Australasian Plant Conservation

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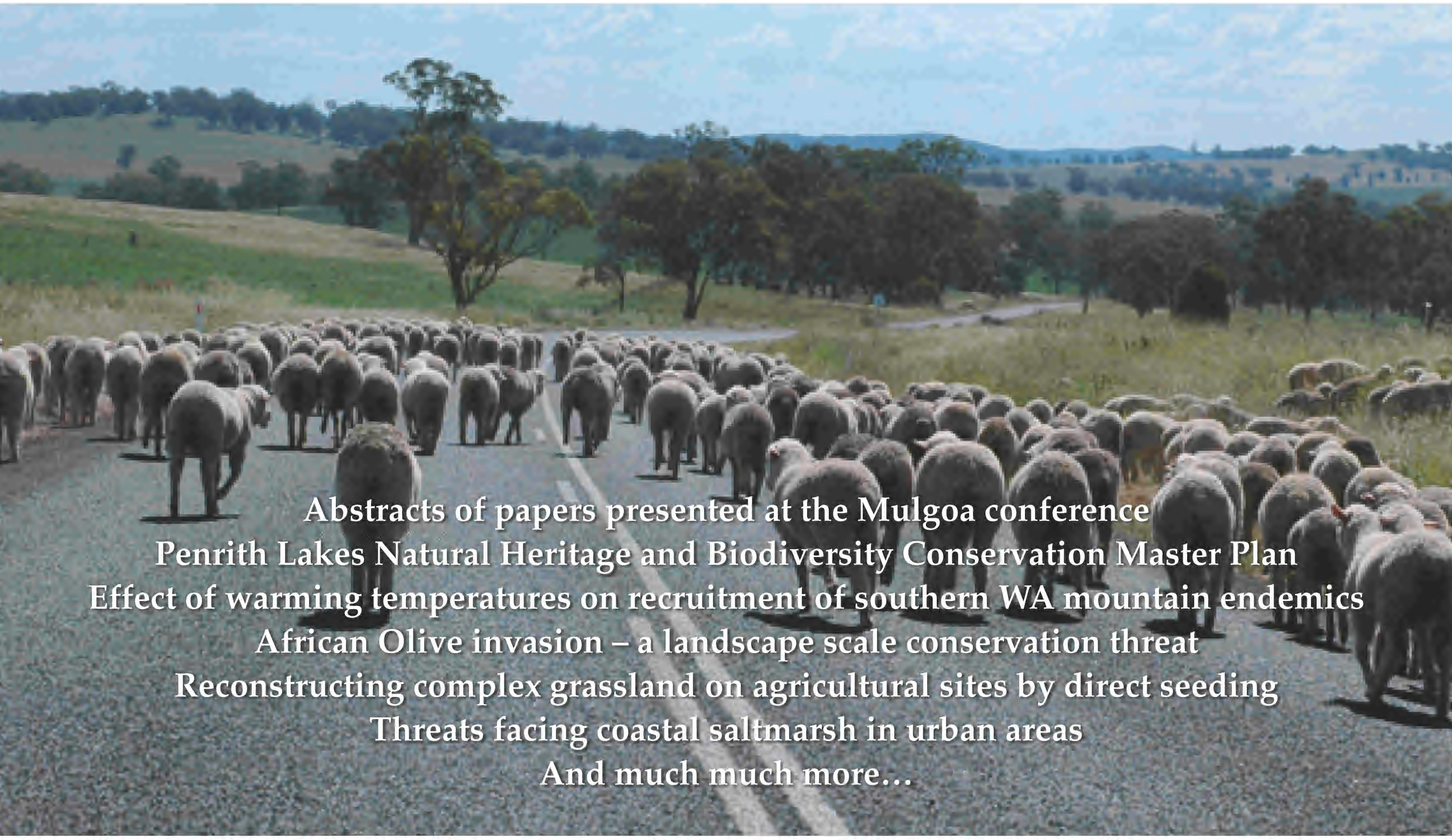

Abstracts of papers presented at the Mulgoa conference
Penrith Lakes Natural Heritage and Biodiversity Conservation Master Plan
Effect of warming temperatures on recruitment of southern WA mountain endemics
African Olive invasion – a landscape scale conservation threat
Reconstructing complex grassland on agricultural sites by direct seeding
Threats facing coastal saltmarsh in urban areas
And much much more…

SPECIAL THEME: OUR DECLINING FLORA – TACKLING THE THREATS

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Australasian Plant Conservation

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ANPC Inc.
Mission Statement

"To promote and improve plant conservation"

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the June-August 2008 issue is Friday 30 May 2008.** The theme of the June-August issue will be "Woodlands", and it will contain additional papers from the 2008 ANPC Conference. General articles are also very welcome. Please contact Rosemary Purdie if you are intending to submit an article: Rosemary.Purdie@environment.gov.au.

Authors are encouraged to submit images with articles or information. Please submit images as clear prints, slides, drawings, or in electronic format. Electronic images need to be at least 300 dpi resolution, submitted in at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf.

Please send articles, no more than 1100 words, as a MS Word (2000 compatible) or rich text format file, on disk or by email to: Rosemary.Purdie@environment.gov.au.

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Front cover: (left to right) Insepecting weed control, Mulgoa; housing development; Privet fruit. Photos: Rosemary Purdie. (main) Rural landscape, NSW. Photo: Murray Fagg.
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From the President

Bob Makinson

Royal Botanic Gardens & Domain Trust, Sydney

The theme of this issue comes from ANPC's 7th National Conference *Our declining flora – tackling the threats*, held in Mulgoa, NSW on 21-24 April 2008. The conference examined threatening processes in plant conservation, and their management at the species, plant community and landscape levels.

Natural plant species and communities are essential for a healthy environment but all around us we see signs that many are in decline. We face a continuing onslaught of new arrivals of actual or potential weeds, feral pests, and diseases, and increasing impacts from those already here. Direct human impacts on native vegetation continue through clearing and habitat modification. Added to these are the impacts on native biodiversity of climate change – more extreme temperatures and changes in rainfall – for which we have no roadmap. Presenters at the conference gave the latest analyses and research on these processes, and case studies of the range of responses being tested in practice.

Australia has come a long way in terms of understanding the need to conserve our living native species and ecosystems. Yet as a society we still struggle to integrate the conservation ethic in our social and economic planning, and to invest at the scale necessary to understand our biodiversity and reduce its rate of decline.

There has been real progress in the last decade in recognising and understanding regional and landscape level ecological processes and threats that operate at these levels. Increasingly, government investment and structures in natural resource management are directed at attempting to address these threats in a way that is strategic at both the human and the biophysical levels.

This more regional approach is to be applauded, but it is important also that we do not fail to address the finer-scale priorities – patches, sites, and individual species – that will not be caught in time by broader-scale habitat protection measures. Moreover, it is these finer-scale cases that are often the key to local community involvement, the best test-beds for innovation, and vital for fostering a love of nature in the coming generation. Government conservation efforts still have a way to go in fully empowering and resourcing the potential energy for conservation in the community.

The Australian Network for Plant Conservation (ANPC) has always stood for *integrated* conservation – combining good science with good practice, *in situ* site and habitat protection with *ex situ* measures like seed-banking, and professional science with community-driven conservation efforts. We specialise in facilitating links and information flow between scientists, conservation managers, and on-ground conservation practitioners. Closer links between these sectors are vital if we are to adequately deal with threatening processes, understand threats, anticipate new ones, and reverse the decline.

We are confident that the Mulgoa conference, and the workshops and courses we have run in recent years (23 in six States since 2002), are playing a useful part in this process – but we depend on you, our members, and those who are not yet members – to help us keep doing so. The ANPC is a largely voluntary organisation. We have an indispensable staff of two, but a great deal of what we do is based on volunteered time and effort. Your suggestions for new initiatives, and your help in getting them funded and implemented, is vital. If our work seems useful to you, please consider joining or becoming more deeply involved.

Note from the Editor

In this issue of *Australasian Plant Conservation* (APC) we have reproduced the abstracts of about two-thirds of the papers presented at our 7th national conference at Mulgoa, and nine full conference papers. The rest of the abstracts and some other papers from the conference will be published in our next issue – APC volume 17(1) – together with papers on the theme for that issue, Woodlands.

ANPC Annual General Meeting, 30 November 2007: President's report

Judy West

Centre for Plant Biodiversity Research, CSIRO Plant Industry

This is a slightly edited version of the President's report presented to the Annual General Meeting in November 2007. It incorporates some salient and still relevant points from the Vice President's (Bob Makinson) report at the 2006 AGM, which was not published in APC.

At the outset I would like to thank my colleagues from the ANPC Committee for picking up many of the tasks when I was unexpectedly out of action for the last few months of 2006. In particular, my special appreciation to Bob Makinson who stepped into the President role and as usual dedicated much time to the ANPC.

I take this opportunity to look back at the past year and to identify a couple of areas which I think we might progress further in the future.

Have we fulfilled our mission ***"To promote and improve plant conservation"*** in 2007?

The ANPC has raised its profile and, for a small organisation, contributed significantly to plant conservation objectives for Australia.

Membership

Membership has increased slightly. As at November 2007 we had about 380 members, including 41 organisational members. It appears that our policy of mailing non-current members with reminders produces reasonable response to warrant the effort. The option of paying subscriptions for a 3-year period contributes positively to the continuity.

The arrangement with the journal *Ecological Management and Restoration* whereby ANPC members can elect to take a discounted *EMR* subscription together with their ANPC membership, appears to be attractive to a number of members. Currently 33 ANPC members have elected to take up the offer. The reciprocal arrangement extends to placing an advertisement in each other's journal at no cost.

Committee

New members who joined the Committee this time last year have contributed well, bringing different experience and extending the network. The team works comfortably together with many complementary skills and we now have better geographic coverage. Together we have achieved a lot.

Committee members contribute enormously to the organisation, even though many of us feel we don't achieve as much as we would like. As a relatively small national NGO the ANPC suffers from the lack of full time staff to progress much of the agenda and instead relies on the volunteer commitment of its members. Two years ago Committee members put in considerable effort to develop a strategic plan with identified strategic directions, but within the limitations of available time and a number of reasons we have not been able to gain traction and to progress it sufficiently. I hope that this might be able to rise to a higher priority during 2008.

Staffing

Our staffing situation remains essentially unchanged. We have an excellent and highly experienced Project Officer in Sally Stephens. Sally's organisational ability has contributed greatly to the success of the workshops and training courses she has planned and run, and we have benefited from her personal credibility and large network of conservation contacts.

Pam Strickland has been employed part-time as Office Manager and has been maintaining order in the office, handling membership records, workshop registrations and publications sales. Pam developed confidence in handling the financial management associated with her tasks, especially using MYOB with guidance from our Treasurer.

The ANPC would not operate without the dedication and diligence of both Sally and Pam and I thank them on behalf of the organisation. They have been ably supported by volunteers contributing their time to various office and website tasks, particularly in the past year by Merryl Bradley and Richard Bomford.

Finances

The financial statements tabled at this meeting provide the full picture of the organisation's finances. Our Treasurer, Jim Crennan, has done an outstanding job in managing the financial matters and providing us with extremely helpful baseline information. He will be reporting on a modest surplus for the 2006/07 financial year, and I am sure will be encouraging us to secure more financial support to maintain the momentum!

Several grant applications were submitted during the year and others resolved since the last AGM, including:

- *Plant ID of ACT grassy ecosystems flora*: Canberra, 22-23 November – supported by Environment ACT.

- *Native vegetation management and rehabilitation*: Coffs Harbour, 14-15 March – supported by NSW Environmental Trust.
- National Forum: Canberra 17-19 April 2007 *What lies beneath? The role of soil biota in the health and rehabilitation of native vegetation* – supported by Envirofund.

Other support has been secured from the Australian Government's Grants to Voluntary Environment and Heritage Organisations (GVEHO) program, and Envirofund Round 9 for two workshops in the Western Australian wheatbelt to be run in March 2008. We were also successful in obtaining some funds for three years from the NSW Environmental Trust under their *Lead Environmental Community Groups Grants Program.*

The hosting of the ANPC by the Australian National Botanic Gardens remains a crucial support for us, and a major contribution by the ANBG to the national effort for plant conservation. We are further developing an effective working relationship with the ANBG, including the establishment of an MoU with it.

We gratefully acknowledge the support over the past twelve months for some of our activities by the NSW Environmental Trust, the Australian Department of the Environment, Water, Heritage and the Arts, and the ACT Government.

Conservation Training Activity

Increasingly the delivery of training courses has been the core of our activities – training and plugging knowledge gaps linking science and on-ground practitioners. We now present well-received courses on threatened species conservation, translocation practices and ecological principles, plant identification and technical aspects of bush remnant conservation and rehabilitation. The evaluation summaries for all the workshops are overwhelmingly positive.

The second of the two workshops on *Native Vegetation Management and Rehabilitation* was held in Coffs Harbour on 14-15 March and attracted 111 participants (see APC 15(4):4-6).

In April 2007 in Canberra, we held our first new-format National Forum, on the theme *What lies beneath? The role of soil biota in the health and rehabilitation of native vegetation*. The 80 registrants participated in a mix of presentations, practical workshops and field techniques, particularly focusing on soil/plant interactions. The Forum provided the opportunity to raise awareness of the outcomes of recent much-needed research in this area, together with practical knowledge and application (see APC 15(4):4-6).

Recently in November ANPC ran an oversubscribed two-day workshop in the ACT – *Plant ID of ACT grassy ecosystems flora*. The response to this type of training course (more than 90 participants), relating plant identification to capability to assess vegetation quality, indicates a strong demand in the community and something that we will explore holding in other regions.

We are now gearing up for the Annual Conference to be held in Western Sydney in April 2008. *Our declining flora – tackling the threats*, will provide a venue for exploration of threatening processes and combining resources of best available science and practical experience.

Publications

The quarterly bulletin, *Australasian Plant Conservation*, remains a vital part of our activity, and provides a good means of building links to both scientists and practitioners, as well as a benefit to members and a means of drawing in new layers of support. The practice of publishing issues with a particular theme has proven popular with members and provides a welcome outlet for many practitioners. The Editor Tom May has done an excellent job at the helm of *APC* and together with a small editing and production team produces a publication of high quality material.

Other ANPC publications distributed during the past year are the updated *Translocation Guidelines* of 2004 and the now dated *Germplasm Conservation Guidelines for Threatened Species* (1997). Agencies in several states and territories are now specifying the new edition of the *Translocation Guidelines* as the standard to be followed in conservation translocations.

In response to the expanding area of interest nation-wide in germplasm conservation we embarked on a revision of the *Germplasm Conservation Guidelines.* This is progressing in partnership with the Millennium Seed Bank Australian Partners consortium and will incorporate the extensive base of Australian experience in both research and conservation practice. It is anticipated this revision will be published in 2008.

Awareness Raising

During the past year we have specifically targeted some activities to promote and raise awareness of the ANPC and its goals. This has included producing a flyer for wide distribution, and making presentations to various bodies and at relevant events. Members of the Committee are currently working on a sponsorship package which can be developed for particular targets.

Forward Planning

I would like to see us progress the identified directions in our Strategic Plan, and will work with the team towards that in the next couple of years. Besides the ever-present funding issues for NGOs such as ANPC, there are some specific areas that clearly could be further developed, each of which could benefit from local member initiatives and ideas.

- **Membership building** – the extensive interest and attendance at our training courses and workshops is not translated into paying memberships. We have followed a practice of providing presenters and field hosts with complimentary membership for one year (averaging about 25 per year), but new recruitment and sustained memberships from among course and workshop attendees is patchy. We recognize there are many factors contributing to this issue, including maintaining relevance for an NGO with a national remit, to members and their initiatives at the local and regional scale. Improving our capability in this area is essential for both new recruitment and member retention.

- **Geographical scope of ANPC activities** remains focused on south-eastern Australia, influenced by membership focus and where we have been able to secure funding. In recent years we have been able, with much assistance from local agencies, to hold significant activities in south-east Queensland (two courses and a translocation workshop), Adelaide (the 2005 Conference), Victoria (workshop in Bendigo) and Western Australia (a translocation workshop, two woodland wheatbelt workshops). We'd like to do more beyond NSW and the ACT, and to a great degree this depends on local members in other areas identifying possibilities (themes and funding) and helping to drive specific initiatives. Please feel free to make suggestions.
- **Website development** – the ANPC website requires substantial revision and an update so that it can better provide information relating to plant conservation. Volunteers have been able to incorporate material and notices, but the bigger issue is largely a shortage of resources to develop the website in a structured manner. The Committee has identified this as a priority for 2008.
- **Partnerships** – the ANPC has been exploring opportunities to develop various types and levels of partners. A small organisation such as ours needs to partner to succeed. We do it pretty well, but there is a need to expand and probably into non-traditional areas.

Finally, I would like to pay tribute to the contributions of those who are leaving Committee positions at this AGM.

- Tricia Hogbin is 'retiring' from the Committee. She has been an extremely effective committee member, including a period as Secretary, and has contributed greatly to running and presenting at workshops and developing and revising publications. ANPC has benefited greatly from Tricia's strong organisational abilities as well as her practical knowledge of threatened species conservation. Our thanks go to Tricia for her work on the committee and for her contributions to ANPC.
- Tom May is also 'retiring' from the Committee and the APC editorship. In addition to his editorial role, outlined above, Tom has provided an important link with the Royal Botanic Gardens Melbourne and to cryptogam and fungi conservation, which will almost certainly have greater emphasis in the future. Thanks Tom very much for your generous support.

I step down from the President position at this AGM and wish to express my gratitude for the great support I have had from members and particularly Committee members during the past four years. I have enjoyed this role even if feeling a little frustrated at times in not being able to secure a more solid funding base in order to move the agenda forward. ANPC is making a sound contribution and I look forward to being able to continue to contribute.

STOP PRESS

The Eighth National Conference of the Australian Network for Plant Conservation will be held in Perth, WA in 2010.

Watch out for details of the conference, date and themes.

Abstracts of papers (first batch) presented at the ANPC Seventh National Conference: *Our declining flora – tackling the threats* 21-24 April 2008,Mulgoa NSW

Critically endangered and nowhere to go: A flora case study from the South Coast of Western Australia

Emma Adams

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Esperance lies on the south coast of Western Australia, which forms part of the only internationally recognized biodiversity hotspot in Australia and is renowned for its high floral diversity and endemism. Major threatening processes include loss of habitat due to the spread of *Phytophthora cinnamomi*, encroaching salinity, inappropriate fire regimes and climate change. This paper will present the Region's strategic response to managing one of its 26 Critically Endangered taxa.

Lambertia echinata subspecies *echinata* is known from only three extant populations consisting of less than 250 plants in total in the heavily *Phytophthora cinnamomi* infected Cape Le Grand National Park. *Lambertia echinata* subsp. *echinata* is found growing on the shallow lateritic soils on the coastal granite outcrops. The landscape of this national park has been vastly altered due to *Phytophthora cinnamomi* resulting in a significant collapse of the park's vegetation communities.

Recovery actions to date have included critical habitat mapping, phosphite application, seed conservation and seed orchards. Several reintroductions have also been attempted to date but have been unsuccessful due to the limited availability of suitable habitat and the extensive spread of *Phytophthora cinnamomi*. The extant populations are beginning to show severe signs of deterioration due to the disease. Located less than 2 km from the southern ocean any temperature warming associated with climate change could also further impact on this taxon. Whilst ex-situ conservation by way of seed conservation and seed orchards has been a key management strategy, this species is very much critically endangered with nowhere to go.

A special case? Experimental *Phytophthora cinnamomi* mitigation at a wild site of the Wollemi Pine

Tony D. Auld

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The Wollemi Pine (*Wollemia nobilis*) is an iconic species of major conservation significance. The species is restricted to a single catchment within Wollemi National Park NSW. The recent identification of the pathogen *Phytophthora cinnamomi* within the main stand of remnant trees, along with symptoms of dieback on several Wollemi Pine individuals has highlighted the need for catchment-wide phytosanitory control measures in the wild habitats of the species. Attempts to mitigate both the spread of the pathogen and its impact on the Wollemi Pine have included closure of the critical habitat for the Wollemi Pine, surveillance of the wild catchment and associated access points, phytosanitory procedures for anyone entering the catchment, monitoring of plant health, extensive soil sampling for the pathogen, as well as *in situ* protection of individual trees and drenching. It is too early to tell how effective these techniques may be in controlling the pathogen and its impacts. An optimistic aim might be eradication of the pathogen, but minimising spread and maintaining plant health are more realistic goals.

An evaluation of a Waratah theft reduction strategy

Doug Beckers[1] and Cathy Offord[2]

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The long-term viability of some Waratah (*Telopea speciosissima*) populations within Brisbane Water National Park near Gosford, is potentially under threat due to illegal harvesting of the blooms. Recent wildfires triggered the mass flowering of Waratahs and it was found that many of the blooms in one area were removed illegally. In order to try and reduce the incidence of wildflower theft, the National Parks and Wildlife Service applied blue acrylic paint to some of the blooms in the hope that this would reduce the attractiveness to picking and hence reduce the incidence of theft. Signage, media coverage and educational walks were also instigated in order to raise awareness about the implications of Waratah bloom theft. Despite these efforts, over one quarter of all blooms were deliberately picked, which consisted of both painted and unpainted blooms. Most of the blooms removed (80.6%) were cut from the stem, with the remainder (19.4%) being snapped. The painting of blooms did not significantly reduce the incidence of wildflower theft when compared to unpainted blooms. Painting of blooms had no significant effect on seed quality, i.e. seed production per fruit, seed germination percentage, and seed germination rate or seedling vigour when compared to unpainted blooms. The results indicate that the process of painting Waratah blooms to reduce theft was relatively ineffective in this area and alternative strategies should be considered to reduce Waratah bloom theft.

A challenge to our conservation faith

Ashley Bland

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Despite significant financial investment in conservation interventions, many of our endemic species continue to decline in range and abundance. Why are we not achieving the broad and significant changes to our ecosystems that are needed to halt the decline? Often we claim that resources are scarce, change is too fast and the pressures on our fragile fragments of native vegetation too strong. Another possibility is that our approaches and priorities towards conservation and environmental restoration have been too narrow. What if:

- Weeds are not the priority they are believed to be?
- 'Local provenance' is a waste of energy and even counter-productive?
- Planting times and scheduling of works has to change season?

The fundamental paradigm in these issues is a focus on single species over the health of whole systems and the services they provide. Furthermore, the limited capacity of humans to think or work over long time cycles and reluctance to admit wrong-doing are strong barriers. Here we explore the notion that successful reinstatement of ecosystem function is critical to halting the decline of our flora and the implication that to achieve this, some long-held ideals may need to change.

Some (fading) cultural landscapes of the South-East forests

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Walking can bring understandings not available to those who choose to drive from place to place, especially in country as difficult as that in the rough triangle between Bermagui, Mount Kosciuszko and Mallacoota.

When the Europeans arrived on the Monaro tablelands they found the rugged mountains were a barrier to progress, but the old Aboriginal clans came to the rescue and showed them ways that had been used for thousands of years. 'Why it was the blacks, and nobody else who opened up the country…' said Bernard O'Rourke, one of the first to settle the region in 1843. 'They led him, and you, and everyone else here and there.' These pathways generally became the first roads. In the wilder backcountry parts of them remain today, largely as they were.

The Penrith Lakes Natural Heritage and Biodiversity Conservation Master Plan: Re-establishing and sustaining four Cumberland Plain Endangered Ecological Communities

Sandy Booth, Jocelyn Powell, Peter Ampt, Howard Wildman, Jane Aiken and Justin Russell

See Booth *et al*. in this issue, pp 14-15.

Threatened flora recovery on Lord Howe Island

Dianne Brown[1] and Sue Bower[2]

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There are eight threatened flora taxa currently listed for the Lord Howe Island Group. Threatening processes include weed invasion, habitat loss and small population size. As part of the Lord Howe Island Biodiversity Management Plan, the Dept of Environment and Climate Change and the Lord Howe Island Board have commenced a comprehensive threatened flora monitoring and rehabilitation program. This program is establishing comprehensive baseline data on population numbers and is providing a more thorough understanding of threats and autecological information. In addition, habitat restoration is being undertaken in sites where this is considered a priority.

The presentation will give a brief overview of the Biodiversity Plan, the threatened flora of Lord Howe Island, the threatening processes, and the flora recovery program.

Plant communities of seasonal clay-based wetlands of south-west Australia; weeds, fire and restoration possibilities

Kate Brown, Grazyna Paczkowska, Bob Huston and Nola Withnell

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The plant communities of seasonal clay-based wetlands of south-west Australia are amongst the most threatened in Western Australia. Over 90% have been cleared for agriculture and urban development with weed invasion a major threat to those that remain. The South African geophyte, *Watsonia meriana* var. *bulbillifera*, is particularly invasive within these communities forming dense monocultures displacing the herbaceous understorey. Significantly over 50% of the flora of clay-based wetlands is annual and perennial herbs and the flora includes many rare or restricted taxa.

Meelon Nature Reserve, a remnant clay-based wetland on the Pinjarra Plain 200 km south of Perth, was the focus of a three year study investigating the effectiveness of the herbicide 2-2DPA (Dalapon®, Propon®) in controlling populations of *W. meriana* var. *bulbillifera*. The impacts of the herbicide on native flora, the response of the native plant community to *W. meriana* var. *bulbillifera* removal, and the compounding impacts of fire were also examined.

Tackling the threat of illegal clearing of threatened species – problems and potential solutions

Sarah Burke and Penny Finlay

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The NSW DECC receives a large number of reports every year of alleged 'pick' of threatened plants, endangered populations or endangered ecological communities and/or 'damage' to their habitat. These incidents are investigated as breaches of the *National Parks and Wildlife Act 1974*. Although a high number of reports are received, very few result in prosecution. The reasons for this are discussed in the context of the often complex legislative requirements and high level of resourcing involved. DECC is attempting to address these shortcomings by improving the capacity of staff to respond to breaches, developing better compliance protocols and using a more effective mix of regulatory 'tools'. This talk will outline the legislative framework for protecting threatened species in NSW, describe the various options available for responding to reported breaches of this legislation and provide examples of how these approaches are being applied on the ground to get better regulatory outcomes.

The presentation should also help participants have a better understanding of how they can assist in the process of getting improved and timely evidence essential for any regulatory action.

Does control of invasive plants lead to native plant species recovery? The need for monitoring protocols

Alana Burley and Paul Downey

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Invasive plants are acknowledged as a major threat to biodiversity, but few native species have been identified as being at risk. As a result, management approaches may not effectively target the recovery of the native plant species at risk. An informal survey of coastal invasive plant control practitioners in NSW revealed few monitoring programs that could report on the recovery of the species at risk. In addition, many control and monitoring programs lacked clearly defined objectives, often leading to the premature abandonment of the program. To address these problems, standardised monitoring protocols were developed as part of a NSW initiative to reduce the impacts of the invasive plant *Chrysanthemoides monilifera* (L.) Norl. on native species. This initiative encompassed 350 sites involving many different stakeholders and land tenures. In addition, there are varying resources available and differential skill levels across site managers, as well as dissimilar occurrences of the native species at risk. Thus a flexible monitoring approach was required. The guidelines developed contain three tiers of complexity, with techniques ranging from simple qualitative assessments to robust research studies, allowing managers to adopt the tier most suitable to their desired objectives and outcomes. Defining objectives prior to conducting monitoring is an essential component of the guidelines. The benefit of this approach is that consistent monitoring protocols are established state-wide to determine the response of native species to *C. monilifera* control programs with a central location of data. These monitoring guidelines are now being adopted for other widespread invasive plants threatening biodiversity in NSW.

Conservation status of the Victorian flora: a progress report on the current review of status using IUCN Red List categories and criteria

David Cameron

Arthur Rylah Institute for Environmental Research, Heidelberg, Vic. Email: David.Cameron@dse.vic.gov.au

Following circulation by the IUCN Species Survival Commission in 2001 of the IUCN Red List Categories: Version 3.1, the Victorian Department of Sustainability and Environment began reviewing the status of Victorian plants using the IUCN Red List categories and criteria. This presentation provides a progress report on the review to date and assesses the impact of adoption of IUCN criteria on the perceptions of risk and rarity in comparison with current and earlier approaches to conservation status assessment. Important questions include how existing authoritative and legislative lists translate into IUCN categories and whether status under, for example, the Victorian Rare or Threatened Species (VROTS) approach in the DSE Advisory List or, at the national level, the now superseded ROTAP approach, is a useful predictor of IUCN status. Early indications from a review of status of the rich Victorian orchid flora published by Backhouse and Cameron in 2005 suggest a smooth and predictable translation but the icon status of orchids and their 'canary in the mine' status as early indicators of environmental stress make this an unrepresentative family. Case examples of a range of families and genera suggest that the translation is far from smooth and that current status is often a surprisingly poor predictor of IUCN status. The Victorian experience may not be representative of the national trend since Victoria is the most settled and alienated state and its boundaries are arguably the least biogeographically coherent of any Australian jurisdiction.

Phytophthora Dieback disease mitigation in Western Australia

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For over 150 years the introduced plant disease, *Phytophthora cinnamomi* (Phytophthora dieback) has been quietly devastating the native plant communities of the south-west of Western Australia. The scale of this threat is now becoming clear with 40% of the native plant species in the south-west under threat along with a number of the state's threatened plant communities and unique animal habitats. Some plant species are now critically endangered because of *Phytophthora* impact with *ex situ* seed storage and seed orchards the only options currently available to prevent extinction. This presentation will overview the scale of the threat to the states native flora and fauna.

Further, the presentation will outline the roles of the different Phytophthora Dieback organisations in WA and the part they play in the management of this plant disease across the south-west of the state. The State Government has developed a Dieback Response Framework consisting of strategies and actions to combat this threat and has recently drafted a Phytophthora Dieback Management and Investment plan for Western Australia. A Dieback Response Group has been formed that will ensure the Framework is implemented with the support of state and local government, landowners, industry and community groups.

Species based approaches in plant conservation: understanding rarity and threat

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A key issue in conservation biology and the ongoing management of rare and threatened species is understanding rarity and how it relates to threat and threatening processes. Rarity describes a species' distribution, abundance, and habitat specificity, while threat relates to the species' ability to persist over time and its risk of extinction. These issues are largely species- and population-based and provide the foundation for assessing conservation status, proneness to extinction and assigning species to different categories of threat. The latter has been developed and used by the IUCN to compile the comprehensive Red Lists of the world's plant species threatened with extinction. Understanding causes of rarity has been investigated in the context of various frameworks in which it has been categorised both in terms of temporal persistence and spatial distribution. A series of examples will be given investigating both rarity and threat covering demographic, life-history and genetic characteristics of species at the population level. These studies will be used to demonstrate how a clear understanding of both rarity and threat can greatly assist in the conservation and management of rare and threatened species and other species of conservation interest.

Will warming temperatures associated with climate change cause a reduction in recruitment leading to extinction for narrow range mountain endemics of southern Western Australia?

Anne Cochrane and Matthew I. Daws

See Cochrane and Daws in this issue, pp 16-18.

Community-based monitoring: exploring the role of friends groups in terrestrial park Management

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The resource shortfalls in protected area management globally are restricting the capacity of professionals to conduct the environmental monitoring and evaluation required to form the basis of park management decision-making. The increasing recognition of the value of community involvement in natural resource management provides an opportunity to explore how Friends Groups (Community stewardship groups) who conduct monitoring in protected areas contribute to park management. To achieve this, Friends Groups active in protected areas in Victoria were interviewed, while local park rangers from the lead protected area management agency, Parks Victoria, were sent a postal questionnaire.

The findings highlighted that Friends Groups conducted a diversity of monitoring projects, addressing the various threats and natural assets present in their parks. Factors like monitoring skills and ecological knowledge base, combined with task motivation and social capital development, all play a role in the capacity of a group to partake in monitoring. The park management context means the relationship between Friends Groups and rangers plays a role in the extent of monitoring conducted by Friends Groups. The responses received from both rangers and Friends Groups suggested that community monitoring data perceived to be accurate and relevant to park needs was consistently used to inform management. Despite recognition of the overall benefit of community-based monitoring to park management, Friends Groups faced challenges to monitoring continuity and capacity, in the form of dwindling volunteer numbers, and skill and knowledge limitations, respectively.

Easy as ABC – Victoria's 'Actions for Biodiversity Conservation' database

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The ABC (Actions for Biodiversity Conservation) is a web-based information system which allows managers of threatened species and communities to clearly identify what needs to be done for threatened species, why, when, where and by who – and whether it was done or not.

ABC makes it easy to assign priorities to locations and actions, to identify threats and enter results for each action. Reports can be generated by any user to show what actions are being undertaken for a particular species, community or potentially threatening process; a group of species; across a geographic area; or by a particular land manager. Data collected and used in the monitoring of species, locations and actions can then be communicated to key investors (such as DSE, Parks Victoria, Catchment Management Authorities, local governments and non-government agencies).

ABC is currently leading the way in planning and reporting on threatened species management. The future will see ABC further developed to show the condition, trends and possible future outcomes for threatened species, communities and threatening processes.

Revegetation – the role of small quality sites

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This presentation applies to degraded sites that are typically sprayed out and revegetated. It is sometimes appropriate to work on small sites and develop a high quality outcome. Such sites should not be dismissed as just gardening with local plants.

The advantage of working with small sites is that more effort can be directed to a given area and local plant knowledge is developed through observation. Provided that field workers have appropriate skills, quality can be achieved by making repeated visits to:

- remove all weeds,
- search for and protect natural regeneration
- introduce seeds and plants of appropriate local species.

Quality revegetated sites have no weeds and a diverse range of indigenous species developing into resilient native vegetation. In time, many small, quality sites add up to a large area of functioning native vegetation whereas an equivalent area revegetated in the one project is likely to become a weedy plantation of trees and shrubs.

It is vital to take on an area that is small enough to be thoroughly worked with the knowledge and workforce available. As knowledge increases, larger bites can be taken as the site expands.

Factors that militate against the successful development of small quality sites

- Lack of plant knowledge
- Lack of site assessment experience
- Lack of persistence and attention to detail
- Starting with too large an area
- Funding for short term projects rather than a long-term processes
- Public ignorance of the value of weed-free sites

African Olive invasion – responding to a landscape scale conservation threat in western Sydney

Peter Cuneo, Carol Jacobson and Michelle Leishman

See Cuneo in this issue, pp 20-21.

The last loaf of bread

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Threats, responses, knowledge, policies, ideas and action; Joe was an ordinary bloke and knew nothing about any of these. Scientists, conservationists and politicians he had heard about. He had even met a few at dinner parties, but did not really know what they did and, to be honest, it did not concern him much. What Joe did have was a passion to solve a problem. What to do if this was the last ever loaf of bread.

Weed management and threatened plant species conservation – lessons from listing weeds as Key Threatening Processes

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The NSW *Threatened Species Conservation Act 1995* allows for the listing of Key Threatening Processes (KTP), thereby acknowledging serious threats to biodiversity. In NSW, the KTP listings have been skewed towards invasion by alien species, as they threaten 45% of all listed species/communities in this state. In 1999 *Chrysanthemoides monilifera* (bitou bush) was the first weed to be listed as a KTP and a threat abatement plan (TAP) was prepared. This was the first weed TAP in Australia and has lead to a fundamental change in weed management, in that control actions are now focused towards conservation. The development of this TAP required new methodologies to determine the biodiversity at risk. These methodologies have been adopted for other weeds listed as KTPs. For example, a national TAP being prepared for *Lantana camara* has identified 128 plant species and ten ecological communities that are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* which are also at risk from lantana. While these two TAPs have been instrumental in developing weed management for biodiversity conservation, they only account for two weed species. To manage multiple weed threats, a new project to establish regional lists of weeds posing a threat to biodiversity and identifying the biodiversity at risk has commenced in collaboration with the Catchment Management Authorities in NSW. The outcomes of this project will feed into the NSW Priorities Action Statement, which contains actions to simultaneously address threats to various threatened species, thus enabling broader weed management for biodiversity conservation.

Managing the threat of Phytophthora dieback in Western Australia – a whole of community response

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The south-west of Western Australia is one of the world's top 25 biodiversity hotspots. The introduction of the devastating plant disease, Phytophthora dieback, is arguably the greatest threat to the biodiversity of this globally important region. The disease is also a significant cost for many industries including mining, forestry, horticulture, nurseries, extractive industries, construction and eco-tourism. Within infested areas, Phytophthora dieback acts like a Biological Bulldozer by killing many dominant tree and understorey plant species. A number of rare native plants and animals are being driven to the brink of extinction due to the impact of Phytophthora dieback within native plant communities. Currently the disease affects hundreds of thousands of hectares of native bushland and forest within the south-west of the state.

The management of Phytophthora dieback is complex and to be successful requires a whole of community response. Key stakeholders include: State Government Departments; Local Government Authorities; Industry; Universities; Natural Resource Management groups; community based environmental groups; and the general community. The work of two pivotal groups, the Dieback Working Group and the Roleystone Dieback Action Group, has been essential in raising awareness of the threat posed by Phytophthora dieback and building capacity within the community to managing the disease.

The model for community engagement to address Phytophthora dieback in WA and the strategies employed to involve all key stakeholders including the wider community will be discussed.

A catchment approach to managing Phytophthora dieback in the Fitzgerald River National Park on the south coast of Western Australia

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Fitzgerald River National Park on the south coast of WA is one of the most diverse botanical regions in the world, reflected in its designation as a World Biosphere Reserve. Around 2000 species and subspecies of native flowering plants are found in the park, representing nearly 20 per cent of the total number of plant species in WA. Included in this are over 62 endemic plant species with a further 48 plant species more or less confined to the park. This diverse flora supports a number of threatened animals including the critically endangered western ground parrot and the endangered dibbler.

Although the introduced plant disease Phytophthora dieback is widespread across the south coast of WA, the Fitzgerald River National Park is largely free of the disease. Unfortunately, the park is also home to a 185-hectare Phytophthora dieback infestation. Faced with the challenge of containing the infestation within its current micro-catchment, and with no known cure for the disease, the Department of Environment & Conservation in collaboration with the South Coast Natural Resource Management group is implementing a $1.3 million Phytophthora dieback management plan. Funded by the WA State Government through an initiative titled *Saving our Species,* the project aims to prevent the infestation spreading further into the park.

The project is utilising a wide range of innovative management techniques including: a comprehensive hygiene plan; controlled access; a fire management plan; perimeter fence to prevent animal vectoring; root impermeable membranes; fungicide (phosphite) treatment; revegetation of the infested area; and engineering works to alter the sites hydrology. The details of the project and successes to date will be discussed.

Private native forestry, biodiversity conservation and disturbance

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Forest ecologists from ANU have researched private native forest conservation and sustainable management for over 20 years. They focused on private dry sclerophyll forests of the Southern Tablelands, NSW, most of which exist in an ecologically degraded state. To develop options for restoring these forests, the Mulloon Creek Small Scale Silvicultural Demonstration (near Bungendore, NSW) was established in 1991 by ANU Forestry in cooperation with the landholder Mr Tony Coote. Treatments investigated included thinning, fire (no fire), 3 levels of surface disturbance (blading, chisel ploughing, harrowing, none), direct seeding of understorey species (none). Thinning and burning were the most effective treatment increasing overstorey productivity, and the exclusion of all grazers (domestic, feral, native) increased understorey species richness. Subsequently, near Taralga, NSW the beneficial impact of reducing stocking in these dry forests was confirmed. Three stands of different height, stocking and average diameter were examined dendrochronologically indicating that they were in fact the same age (106-111 yrs). Structural differences between stands were attributed to differences in stocking at the time of regeneration. The lowest initial stocking now contains tall trees, 2-3 x the diameter of more densely stocked stands, and supports a rich grassy understorey with more and varied species than the densely stocked stands. These results demonstrate the efficacy of thinning dry regrowth forests, and the potential to fund this treatment through the production of firewood while sequestering additional carbon from increased growth on retained stems.

Developing a general framework of rare plant population responses to landscape fragmentation

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To effectively manage plant populations for conservation, there is a need to provide reliable information on the conditions required for maintaining viable populations. This is particularly true for rare taxa occurring in a fragmented landscape, such as that of south-west Western Australia. Western Australia contains over 45% of Australia's gazetted threatened flora, 80% of which are found within the south-west region. Resources do not exist to undertake comprehensive studies of population dynamics for every rare plant species of this region. By assigning rare plant taxa into functional groups, based on their floral architecture and putative pollinator, and their fire life history (sprouter versus non-sprouter) models will be developed for each functional group. Common congeners were chosen from each functional group for detailed investigation on how rates of pollination and seed production are affected by population size and landscape context. The information gained from these models will be extrapolated to other taxa within each functional group thereby providing guidelines for flora conservation, threatened ecological communities, and restoration/revegetation programs. Here I present findings on the allocation of the 351 declared rare flora of Western Australia into floral architecture functional groups and how these groups respond to landscape fragmentation.

The resilience of restored communities to large scale disturbance by fire

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Habitat degradation and fragmentation have lead to the increasing need for ecosystem and community restoration and are key threatening processes for the Australian flora. The primary goal of restoration and revegetation is to create self-sustaining ecological communities that are resilient to periodic disturbance. Currently, little is known about the dynamics of restored communities, how they respond to disturbance events such as fire and how this response compares to remnant vegetation and production systems such as pine plantations and pastures. The Canberra fires of 2003 provided a unique opportunity to study the long-term response of restored communities (direct seeding and tubestock revegetation) to disturbance by fire and compare this to the response of remnant vegetation and pasture and pine plantations. In this study, 10 burnt and 10 unburnt sites were chosen from each of five vegetation types; (i) direct seeding revegetation, (ii) tubestock revegetation, (iii) remnant vegetation, (iv) pine plantation, and (v) pastures. The 100 sampling sites across the five vegetation types were first surveyed 6 months after fire in 2003 to quantify the survivorship and health of both native and exotic species in each community. In 2006, all sites (except pastures) were resurveyed to assess the health and recovery of each vegetation community. The results of this study indicate that even in drought conditions, revegetation sites (including young revegetation stands) showed substantial recovery from disturbance by fire. This suggests that revegetation can produce highly resilient communities and provide an important basis for landscape restoration in the fire-prone Australian environment.

Reconstructing complex grassland on bare-field sites by direct seeding: learnings from a 3 year, field-scale, experimental study

Paul Gibson Roy

See Gibson Roy in this issue, pp 22-23.

The Australian Flora Foundation

Peter Goodwin

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We have good news and we have bad news! The good news is that the Australian Flora Foundation is an organisation which provides research grants, and whose objectives are very similar to those of the Australian Network for Plant Conservation. Our stated objective is to 'Foster research into the biology and cultivation of Australian plants'. We have four categories of special interest:

1. Conservation of Australian plant diversity, particularly where there are threats from climatic change
2. Plant species with potential for cultivation
3. Cultivation of Australian plants
4. Rare and endangered plants: all applications must indicate how the research relates to the management plan for the species

The bad news is that the Foundation's resources are very limited: we typically give out about four grants per year, of $6,000 to $12,000 per year for a maximum of two years. Hence we try to fund projects where there is considerable leverage – laboratory or field expenses for PhD students, operating support for work by Botanic Gardens, or seed projects which if successful may obtain major support from other funding organisations.

We are at this conference not so much as to encourage you to apply for grants – although you are welcome to do so, but to invite you to join the Foundation. We are in need of ordinary members, and of members with 'conservation' credentials who can spare the time, to join the Council of the Foundation.

Monitoring weed control within Wingecarribee Swamp

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Wingecarribee Swamp is a 350 ha peat swamp located in the southern highlands of New South Wales. It contains a high diversity of plant species, a mosaic of vegetation types and four threatened species: *Lysimachia vulgaris* var. *davurica* (yellow loosestrife) *Prasophyllum uroglossum* (leek orchid), *Gentiana wingecarribiensis* (Wingecarribee Gentian) and *Petalura gigantea* (giant dragonfly). Heavy rains in August 1998 resulted in the collapse of the swamp, the formation of a large channel running the entire length of the swamp and peat washed into a reservoir immediately downstream, forming floating peat islands. As a result of the collapse the swamp experienced major geomorphological and hydrological changes including the interruption of groundwater flows, the drying of some areas of peat and the creation of fissures in the central region of the swamp. Clearing of the surrounding catchment and past peat mining within the swamp is thought to have contributed to the collapse.

The swamp collapse created large areas of bare peat and coincided with the seeding of the highly invasive *Salix cinerea* (willow), resulting in the establishment of over 1 M individuals. A significant weed control program is currently being undertaken to control *S. cinerea* with the weed control methods used varying depending on presence of threatened species. Monitoring has shown that the collapse, subsequent weed invasion and control has affected the distribution of vegetation types and threatened species within the swamp. Conservative estimates showed that the threatened *Lysimachia vulgaris* population was reduced by 85% following collapse, but recovered to 75% of pre-collapse numbers by 2001 and following weed control is expanding into new areas.

Effect of temperature and soil moisture on seed dormancy status of Australian native forbs

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Very few studies have investigated how predicted changes in air temperature and rainfall are likely to affect Australian native seeds. During the reproductive phase, two forbs native to south-west Queensland were grown under high and low temperature regimes, with adequate or reduced water availability. Dormancy status of resulting seeds was measured in terms of germination response to dry after-ripening and warm stratification treatments. Despite being taller and heavier, *Goodenia fascicularis* (Goodeniaceae) plants in the cooler environment yielded fewer, heavier seeds that exhibited more physiological dormancy (PD). *Actinobole uliginosum* (Asteraceae) seeds from the cool environment were also more dormant, although lighter in mass and greater in numbers. In the warm environment the reproductive phase of both species was accelerated and seed PD reduced. The effect of drought was minimal but with reduced water availability *G. fascicularis* plants were shorter and lighter in mass and both species produced fewer, less dormant seeds. Results suggest that these forbs are reasonably tolerant of temperature and water stress and that their seeds are likely to exhibit PD regardless of maturation environment. The maternal environment, particularly air temperature, regulates dormancy status, with seeds collected from a warmer, drier location likely to be more responsive to dormancy alleviating treatments. The implications of these finds with regard to predicted climate change for south-west Queensland will be discussed.

Climate change as a threatening process for Australian terrestrial biodiversity

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There is now widespread acceptance that the climate is changing and that human activities are responsible. The impacts of climate change on species and natural communities will be profound, and in many cases, disastrous. Evidence is accumulating that many species are already responding to the warming trends experienced in the last few decades. In particular, geographic ranges of the more mobile species are shifting poleward and upward in elevation, and the timing of life cycles of many plants and animals is also changing. Species responses to ongoing climate change are expected to be individualistic although some predictions can be made as to which species will respond most quickly. As species respond, the communities that they live in will also change, both in structure and composition.

This talk will briefly review recent climate changes on a global and Australian scale, summarise projections for the future, and outline the implications of these projections for species and communities with a particular focus on the conservation of Australian flora and the implications for conservation policy and restoration ecology.

To save an ephemeral wetland and its threatened plants: A battle with *Carex ovalis*

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In the late 1980s, according to the conservation thinking of the time, a recommendation was made to fence an ephemeral tarn in the dry eastern South Island of New Zealand which was the only site for a woollyhead daisy (*Craspedia* "tarn") and also contained four other threatened plant species: a tiny cress (*Cardamine* "tarn"), a small carrot (*Oreomyrrhis colensoi* var. *delicatula*) and two minute cudweeds (*Pseudognaphalium luteoalbum* subsp. *compactum* and an unnamed *Euchiton* species). The turf communities there, and these taxa within them, were considered to be threatened by cattle trampling, pugging and browsing.

The results of fencing (increasing dominance of the exotic sedge, *Carex ovalis*) are presented. A recent change in management direction is also described and input from other conservation managers is invited.

Tackling weed invasion to restore threatened plant habitats: the Threatened Plant Action Group approach

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Environmental weed invasion of remnant vegetation is increasingly being recognised as a key threatening process to declining indigenous flora. Weed invasion continues to change the composition of habitat remnants throughout Australia's fragmented agricultural and urbanized regions. Impacts of weeds on threatened plant species include: intensifying competition; displacing individuals; inhibiting recruitment; degrading habitat; and reducing the viability of extant populations. Weed invasion has been implicated in the extinction of several Australian plant species with further unconfirmed cases likely.

South Australia's Threatened Plant Action Group (TPAG) is a community-based organisation that formed during 1993 by members of the public concerned that insufficient action was being taken to protect and recover threatened plant species in-situ. TPAG enjoys a motivated, knowledgeable core of proactive members including: botanists; environmental rehabilitators; and bush regenerators who work toward protecting and managing critical habitat for threatened plant species.

Control of environmental weeds at prioritised sites is a core activity of TPAG. The group adopts a targeted approach to weed control which aims to abate invasion as a threatening processes to indigenous species and to regenerate and restore their habitats, rather than simply killing weeds. We discuss the factors considered by TPAG in managing weed invasion to improve the condition of threatened plant habitats. On-ground control measures are undertaken within a Site Action Planning framework with actions implemented systematically through organised working bees in partnership with other organisations. Illustrated case studies are presented for discussion of relevant management principles and operational techniques.

Towards understanding and conserving Spiny Daisy (*Acanthocladium dockeri*) in South Australia

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Spiny Daisy (*Acanthocladium dockeri*) is a nationally endangered shrub until recently thought to be extinct. It is restricted to five small roadside populations in South Australia's Mid-North. Recent research has improved our understanding of the floral biology and ecology of this species, and genetic studies have revealed that each population is clonal, restricting the number of genetically distinct individuals left in the wild to only five. This paper will discuss the implication of these results to conservation management of this species in South Australia.

Threatening processes and their role in biodiversity conservation

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Threatening processes are mechanisms that cause loss of biodiversity, either through declines or extinctions in local populations of plants and animals or through disruption or degradation to ecological processes. Alongside ecological communities and functional group approaches, they are one of the key concepts for conservation above the species level. They are also important diagnostic tools for declines within species' populations. Taxonomies of threats proposed by The Nature Conservancy and others give a global overview of processes involved. Broadly, they include the loss and fragmentation of habitat, degradation of habitat (e.g. through pollution or structural modification to soils or vegetation), harvesting of populations, adverse disturbance regimes (e.g. fires, floods), interactions between organisms (herbivory, predation, disease) and climate change. In addition to these, there may be indirect threats and opportunities that will impact on the ability of land managers to deal with the direct threats. We will review these briefly in an Australian context with reference to listing of Key Threatening Processes on statutory schedules at Commonwealth level and in some states.

Threats facing coastal saltmarsh (EEC) in urban areas

Jeff Kelleway and Robert J. Williams

See Kelleway and Williams in this issue, pp 18-19.

The rest of the abstracts from the 7th National Conferencewill be published in the next issue of *Australasian Plant Conservation*, volume 17(1).

The Penrith Lakes Natural Heritage and Biodiversity Conservation Master Plan: re-instating Cumberland Plain endangered ecological communities

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Introduction

Rehabilitation of the Penrith Lakes open cut sand and gravel extraction site, just north of Penrith, is managed by the Penrith Lakes Development Corporation (PLDC) Ltd. The site is a major project scheduled on the State Environmental Planning Policy and also has its own State Regional Environmental Plan, SREP 11 – The Penrith Lakes Scheme. All works associated with either the extraction or rehabilitation of the site are directed by the provisions of these two planning instruments and formalised through a Deed of Agreement between the major shareholders and the NSW Government. Consistent with the provisions in the SREP, a Natural Heritage and Biodiversity Conservation Master Plan is being developed for the 1935 ha site. Drawing upon science, best practice, leading expert and local knowledge, the Plan seeks to cost-effectively and sustainably re-establish Cumberland Plain Endangered Ecological Communities on the newly created landforms.

The Master Plan

The Master Plan integrates ecologically sustainable development and natural resource management principles for the planning and development of lands across the site. It includes key outcomes and 'benchmarks' for land use. The Cumberland Plain native vegetation communities most relevant for re-instatement are identified and the challenges to be met in establishing healthy, self-sustaining vegetation communities and animal populations outlined.

The Plan provides detailed policy and strategic direction to ensure new landforms have stable fertile soils able to support native plants and the re-establishment of relevant Cumberland Plain vegetation communities and grasslands on the landforms. It aims to provide resilient ecosystems, vegetative cover appropriate to end uses and habitat for local native animals following re-introduction in some instances. The Plan will also conserve and enhance unquarried lands and their vegetative cover, including the riverbank and Cranebrook Escarpment forests and woodlands, and cultural heritage plantings.

The SREP 11 principles are incorporated within the Master Plan which will be subjected to an Expert Panel review process prior to finalisation. Areas of key need already identified include:

- remediation of soils to ensure healthy functioning ecosystems develop which will support the vegetation and increase its resilience over time;
- establishment of relatively large areas of undisturbed aquatic and terrestrial vegetation, to allow biodiverse (plants, animals, micro-organisms), viable and resilient communities to develop; and
- development and maintenance of structurally and floristically diverse micro-habitats within the main vegetation communities and ecotonal areas between them.

Reinstating Biodiversity – Key Outcomes

The Penrith Lakes site affords an opportunity to re-instate endangered ecological communities and support threatened and/or regionally significant wildlife. By developing lakes and landforms, conserving and enhancing the remnant riverbank and the escarpment native vegetation, a considerable contribution to both local and regional biodiversity conservation can be made. Endangered Ecological Communities that previously existed on-site include Cumberland Plain Woodland, Castlereagh Swamp Woodland, River-flat Eucalypt Forest, Shale Gravel Transition Forest, Shale Sandstone Transition Forest and Sydney Freshwater Wetlands. The Master Plan will guide the reinstatement of these communities. Significant Western Sydney species that have largely disappeared from the area will also be re-introduced or encouraged to re-establish.

Based on scientific research and best practice information a range of biodiversity conservation outcomes are being sought. These include the development of Core Conservation Areas (to protect biodiversity values) that are linked by corridors. These areas embrace enhanced and extended remnant riparian and Cranebrook Escarpment vegetation communities, and a re-established vegetation linkage between these. A segment of Cranebrook Creek will also be re-instated and surviving creek remnants enhanced.

Other intended outcomes are that urban areas play a key role in supporting biodiversity conservation, and urban creek lines and swales integrate biodiversity to enhance water quality, recreational amenity and to provide 'stepping stones' for wildlife. It is hoped the site itself will become a key local and regional wildlife 'bridge'. In time, mosaics of different vegetation communities across the foreshore recreational areas should also enrich fauna habitats, help sustain biodiversity and provide other useful management functions. Buffer zones around sensitive areas and infrastructure will assist in protection of wildlife, be used for fire and infrastructure management, and help prevent incursion of invasive species from other sites.

Key Challenges

Recent scientific research and best practice information on designing urban developments for sustainability (Barnett *et al.* 2000) and for protection of vegetation communities and wildlife (Bennett *et al.* 2000 and DEC 2005) suggests that for healthy native grassy woodland communities (such as those to be re-instated at Castlereagh) to be established and sustained the following 'whole site' minima should be achieved:

- at least 30% of the land area in woodland;
- at least 10% (and preferably 20%) of the land area set aside as 'core conservation' and be connected to others on the site and, where possible, on adjacent lands;
- core conservation areas more than 30-50 ha;
- intensive land use no more than 30%;
- riparian corridor (continuous) along the Nepean River at least 100 m wide (measured from top of bank not including edge buffers) and wider where possible;
- corridors (continuous strips) across the landscape at least 100 m wide to allow for buffers (5-50 m wide);
- corridors along drainage lines/gullies at least 50 m (and preferably 100 m) wide; and
- patches of vegetation across the landscape 20-25 ha in area.

A number of key ecological principals must also be met. In order to establish and 'mimic', as far as possible, the former natural vegetation communities it is essential to use local provenance plant species, reflect naturally occurring community composition, floristic diversity and abundance, distribute plant species on the basis of ecological preferences within natural communities, and develop full structural complexity, integrity and functionality.

For ecosystem services to become established and vegetation community resilience to be sustained and support viable animal populations, it is also essential to develop effectively functioning and viable soil ecosystems and develop and maintain full natural structural complexity and floristic diversity in the vegetation community. The establishment of plant-animal interactions must also be encouraged, corridors and stepping stones developed and maintained to establish connectivity across landscapes, and buffers created around sensitive areas to manage threats.

Monitoring and Review

An Integrated Monitoring Program, using a suite of methodologies, including Landscape Function Analysis and various rapid assessment tools (e.g. CRAM – Community Rapid Assessment, and Monitoring and Biodiversity Rapid Assessment) is being developed to cost-effectively measure performance, track sustainability and enable continuous improvement. Additional consideration of indicators of ecosystem rehabilitation success will help to ensure outcomes are achieved.

Conclusion

Sustainable development requires economic and social activities to be interwoven with ecological principles so that, to the extent possible, natural biodiversity elements can successfully co-exist in perpetuity. While the Master Plan is yet to be completed and approved, its ambitious and long-term nature is recognised, as is the need for continuing, scientific, practical and experiential support to reinstate these threatened ecological communities within a sustainable landscape.

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How will warming temperatures affect recruitment of southern Western Australian narrow range mountain endemics?

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Introduction

Climatic conditions, especially rainfall and temperature, are critically important for the successful recruitment, establishment, survival and reproduction of plants. Climate can influence plants directly (through changes in temperature, rainfall, winds and extreme events) and indirectly (through changes in factors such as fire frequency and behaviour, the spread of disease such as *Phytophthora cinnamomi* and competition with introduced weeds and other native plants). Climate can impact on the distribution and health of plant populations and any change may lead to major range shifts in some species and regional declines in others. One predicted consequence of climate change, for which there is increasing evidence emerging worldwide (e.g. Parolo and Rossi 2008) is the movement of plants to higher altitudes and latitudes as the climate to which they are adapted is displaced.

Current climate models predict that temperatures will rise while winter rainfall decreases across much of fire-prone southern Western Australia (WA). Obligate seeding species in fire-prone environments typically germinate in response to conditions that match the most suitable period for germination. As a result of greater water availability, the periods most favourable for plant recruitment in this environment are autumn and winter (Bellairs and Bell 1990; Bell 1994). However, of concern is the fact that these areas have already experienced a reduction in rainfall since the 1970's (Dracup *et al.* 2005) with the potential to impact negatively on the region's rich plant diversity.

Data on the conditions required for optimum germination of most WA mountain species are lacking. This is particularly the case for species from the botanically diverse but threatened Stirling Range. Consequently, this paper reviews the germination response of 10 plant species from the Stirling Range, including lowland populations of four of these species (Table 1). Because the Stirling Range is located near the coast, is isolated in a flat landscape and has a limited height (max. 1080 m), species can neither migrate upwards nor south in response to climate warming and hence may be highly sensitive to climate change. As many Stirling Range species are narrow range endemics we hypothesised that their narrow distribution might reflect very specific requirements for germination. In particular, we expected that such species would germinate best at comparatively low temperatures consistent with their mountain distribution. In addition, for four species with both mountain and lowland distribution ranges, we compared germination responses for seedlots from both locations. Since establishment depends not only on germination but also seedling growth, we compared the sensitivity of germination and early radicle growth to temperature. The improved knowledge of the risk posed by climate change to southern WA mountain flora will act as a basis for conservation planning and management.

Left: Banksia brownii. *Photo: Sarah Barrett*
Above: Andersonia echinocephala. Photo: *Anne Cochrane*

Methods

A two-way temperature gradient plate (Model GRD1, Grant Instruments, Cambridge, UK) was used to provide 12 constant or 30 fluctuating and 6 constant temperatures ranging from 5°C to 35°C with a 12 hour photoperiod. Seeds were sown either on the surface of filter paper or 1% agar in water in 50 mm or 90 mm Petri dishes. Seeds of *Gastrolobium leakeanum* required scarification of the water-impermeable seed coat to stimulate germination. Germination was scored every two days and was determined by visible radicle emergence.

The optimum temperature for germination (T_o – the temperature which allows the maximum level of germination in the shortest time) was calculated for each germination test at constant temperatures. Radicle growth rates were recorded at each constant temperature by measuring radicle growth over five days. Calculating the mean root growth rate for each temperature provided the temperature for optimum root growth (T_oR_{GR}). Examples of fluctuating temperature germination response are presented using contour diagrams.

Table 1. Temperature (°C) limits for germination and root growth of 10 species from SW Australia. T_o = optimum germination temperature, T_oR_{GR} = optimum temperature for root growth

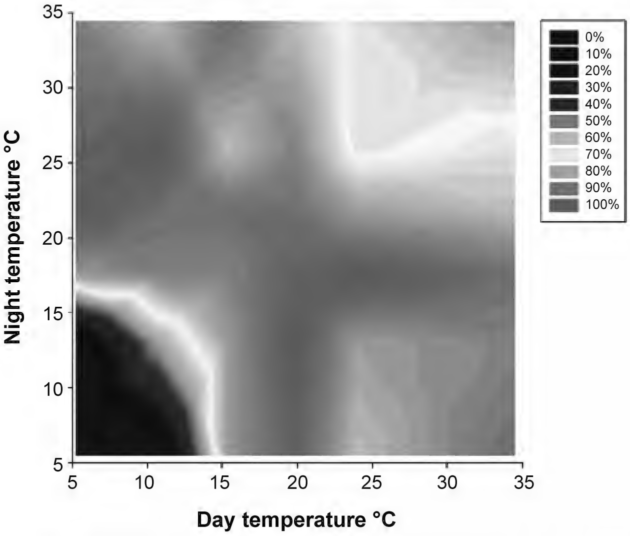
Species	Family	Altitude	T_o	T_oR_{GR}
Calothamnus crassus (Benth.) Hawkeswood	Myrtaceae	800 m	14	20
Andersonia echinocephala (Stschegl.) Druce	Epacridaceae	450 m	14	13
		80 m	17	17
Sphenotoma drummondii	Epacridaceae	1000 m	13	15
Deyeuxia drummondii (Steud.) Vickery	Poaceae	1000 m	17	15
Velleia foliosa (Benth.) K.Krause	Goodeniaceae	800 m	15	25
Gastrolobium leakeanum J.Drumm.	Papillionaceae	900 m	19	21
Banksia brownii R.Br.	Proteaceae	650 m	13	20
		10 m	17	20
Kunzea montana (Diels) Domin	Myrtaceae	1000 m	15	27
Eucalyptus megacarpa F.Muell.	Myrtaceae	800 m	22	27
		50 m	23	27
Allocasuarina decussata (Benth.) L.A.S.Johnson	Casuarinaceae	800 m	19	17
		50 m	20	17

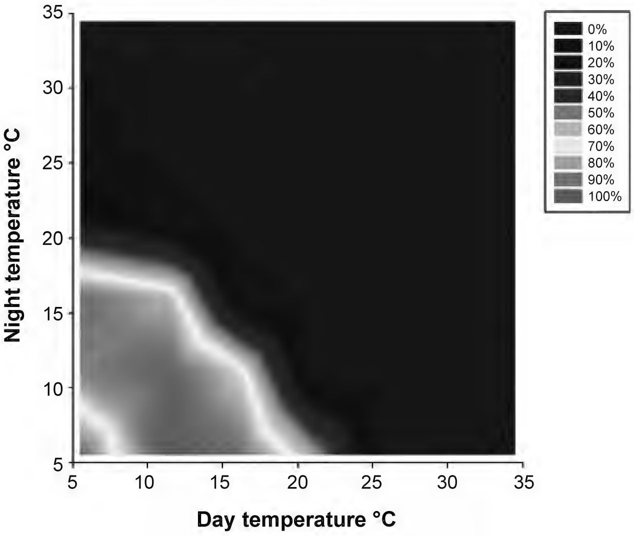
Results and Discussion

Although restricted to the Stirling Range peaks, a number of species (e.g. *Kunzea montana, Velleia foliosa, Deyeuxia drummondii* and *Gastrolobium leakeanum*) had a remarkably wide temperature range for germination (as per the example provided by Fig. 1) with optima between 15 and 19°C. Consequently, a narrow temperature range for germination does not account for these species having a narrow distribution restricted to the Stirling Range peaks. A number of small-seeded species (*Calothamnus crassus, Andersonia echinocephala* and *Sphenotoma drummondii*) displayed a limited and comparatively low optimum temperature for germination (as per the example provided by Fig. 2) and a wider range of temperatures for root growth than for germination (data not shown). Thus these species may prove to be highly vulnerable, at the seed germination stage, to the effects of rising temperatures.

There were only minor differences in optimum temperature responses between low and high altitude populations of more widespread common species like *Allocasuarina decussata* and *Eucalyptus megacarpa* (Table 1). In contrast, *Andersonia echinocephala* and *Banksia brownii*, conservation-listed species but not restricted to the peaks of the Stirling Range, displayed different optimum temperatures for germination for montane and lowland populations, with higher temperature optima for seeds from lowland populations (Table 1).

For some species (e.g. *Bansksia brownii, Calothamnus crassus, Velleia foliosa, Kunzea montana* and both populations of *Eucalyptus megacarpa*) seedling





Top to bottom: Figure 1 (No temperature limits to recruitment) and Figure 2 (Temperature limits to recruitment) are graphs depicting the different scenarios for temperature limits for germination exhibited by species investigated from the mountains of southern WA. Shades of grey show varying percent germination.

performance, measured by T_oR_{GR}, diverged from T_o for germination and there was typically a lower optimum temperature for germination than for seedling performance (Table 1). As a result, climate change may have a greater impact on seed germination than on relative seedling performance for these species.

Although southern WA has experienced climate variation in the past and its native species may have a broad tolerance to extreme climate conditions, we have little knowledge of climate thresholds for southern WA's flora. It is therefore vital that we begin to gather accurate data on species requirements for recruitment as just one small piece of the jigsaw puzzle that will assist our understanding of climate change impacts on native flora.

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Threats facing coastal saltmarsh in urban areas

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Introduction

Coastal saltmarshes are intertidal ecosystems generally vegetated by herbs, grasses or low shrubs (Adam 1990). These systems are vulnerable to sea level rise and mangrove incursion as well as more direct human disturbance including physical, chemical and biological modification. Of concern is fragmentation of habitat that may be occurring unchecked either because the presence of saltmarsh is unknown, or because steps have not been taken to conserve saltmarsh. In a study of the saltmarsh of the Parramatta River/Sydney Harbour (Kelleway *et al.* 2007), these factors led to the categorisation of more than half of the estuary's saltmarsh patches to be in 'poor' condition.

Physico-chemical Threats Facing Saltmarsh Ecosystems

Reclamation

Saltmarshes around Australia have been 'reclaimed' as part of agricultural, industrial, port and residential development. In Parramatta River / Sydney Harbour, for example, the downstream portion of the estuary is now generally devoid of saltmarsh, with seawalls, stormwater canals, residential or industrial development and sporting fields in their place. Historical sources of early settlers in the same estuary show that saltmarshes were extensive in many of the embayments, creeks and intertidal flats during the early years of settlement (Kelleway *et al.* 2007 and references therein). For the most part, little is known of the extent of historical loss in other estuaries.

Fragmentation

The construction of levees, seawalls, jetties, tracks and roads, combined with the proliferation of mangroves has fragmented many of the remaining patches of urban saltmarsh into smaller units. The ecological composition and function of smaller, fragmented patches is likely to be altered (Laegdsgaard 2006), especially in terms of habitat connectivity and overall saltmarsh productivity.

Inappropriate access

Many urban saltmarshes, particularly those accessible from residential areas are subject to inappropriate access and use. Human trampling can cause significant reduction in the number and cover of saltmarsh plants, and continued passage by recreational vehicles (4WD, trail bikes, BMX) has been responsible for the degradation of saltmarsh ecosystems at a number of locations, including within national parks (see Kelleway 2005).

Low-growing, soft herbs such as *Wilsonia backhousei* (Vulnerable, NSW *Threatened Species Conservation Act* 1994) and *Sarcocornia quinqueflora* are particularly susceptible to damage by trampling and vehicles. One of the largest remaining stands of *W. backhousei* in Sydney has been extensively damaged by trail bike use (Kelleway *et al.* 2007). Vehicle use has also been shown to alter saltmarsh hydrology and cause large reductions in the numbers of saltmarsh fauna such as crabs and molluscs (Kelleway 2005).

Dumped materials are often observed in and around urban saltmarshes, particularly at sites that are easily accessible but which are out of public view. Commonly dumped items

Saltmarsh degraded by recreational vehicle use, Georges River estuary, Sydney. Photo: Jeff Kelleway

include garden waste (which has the potential to introduce weeds) and construction materials. Saltmarsh bordering residential properties and council parklands may be subjected to mowing. This can destroy important succulent plant species and disrupt the flowering of grasses.

Rise of sea level

The vulnerability of plants living in and around estuaries to sea level rise has long been recognised (Kelleway *et al*. 2007 and references therein). Saltmarsh and mangrove will be forced further upslope and upriver from their present locations. However, the continued survival of saltmarsh is likely to be limited by local geomorphology, and by anthropogenic structures such as seawalls, roads and buildings. If space is unavailable due to the presence of such structures or steep topography then saltmarsh will disappear. Buffer zones that allow for expansion of saltmarsh should be included in state regional and local planning documents, as well as in the design of new developments adjacent to saltmarsh habitat.

Stormwater discharge

Stormwater discharge into saltmarsh can alter the salinity and nutrient regimes of the wetlands. Direct discharge onto saltmarsh appears to have promoted mangrove colonisation of the saltmarsh in several urban locations (Saintilan pers. obs.). Incursion by freshwater and brackish species such as *Phragmites australis* and *Typha* spp. and exotic weeds may also be facilitated (e.g. Kelleway *et al*. 2007).

Biological Threats Facing Saltmarsh Ecosystems

Mangrove incursion

Evidence of mangrove incursion into saltmarsh exists across the whole of southeastern Australia (Saintilan and Williams 1999) but the causes are as yet unknown. Urban saltmarshes are particularly susceptible, especially where development works appear to have enhanced sedimentation and provided new substrata for mangrove growth. As with sea level rise, the presence of anthropogenic structures greatly limits the ability of saltmarsh to respond to mangrove incursion in urban estuaries.

Exotic species

In southeastern Australia there are a few specialised exotic plant species which can tolerate the waterlogging and/or salinity conditions of saltmarshes. The invasive rush *Juncus acutus*, which is widespread and often abundant in saltmarshes of the Sydney region (Kelleway *et al*. 2007), is of particular concern as it aggressively displaces native saltmarsh species, including the native rush *Juncus kraussii.* Control is difficult and can require a combination of physical removal, herbicide application and mulch covering.

Managing the Threats

The protection of saltmarsh wetlands requires a range of approaches. First and foremost, their distribution needs to be known. A recent estuary-wide field survey of the Parramatta River/Sydney Harbour (Kelleway *et al*. 2007) highlighted the limitations of aerial photograph interpretation in identifying saltmarsh patches under canopy and/or small in size. This showed that previous mapping efforts had missed more than 70% of the estuary's saltmarsh by area. If the threats facing urban saltmarshes are to be identified and managed, then appropriate mapping and assessment protocols need to be employed in the first instance.

Secondly, strong legislative and planning measures which adequately define this ecosystem are required to minimise threats and provide for rehabilitation and continued management. In all states and territories, the highest level of protection will be offered by inclusion in the conservation reserve system (e.g. national parks, marine reserves), provided that adequate resources are supplied for their ongoing management. Legislative protection, such as that afforded saltmarsh as an Endangered Ecological Community under the NSW *Threatened Species Conservation Act* 1994, will provide another tool in addressing threats faced by this ecosystem.

Active, on-ground management options will be best assessed on a site-by-site basis. Controlling access and/or the installation of interpretive and warning signage is recommended for sites undergoing physical disturbance. Education programs for landholders, land managers and the broader community will be part of the solution to many of the management threats discussed above, while community involvement in rehabilitation and maintenance efforts will encourage the long-term protection of coastal saltmarsh in urban areas.

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African Olive invasion – a landscape scale conservation threat

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Background and Biogeography

European Olives (*Olea europaea* subsp. *europaea*) are a deservedly popular crop in many areas of southern Australia, and very much a part of our modern food culture. With extensive olive groves now established by both hobby farmers and commercial growers, olives are also attracting attention as the 'next generation' of woody weeds. Bird dispersal of olive fruits, combined with the Mediterranean climate of the Adelaide Hills in South Australia, has seen European Olives become weedy and invade bushland (Crossman 2002).

In the western Sydney and Hunter Valley regions of NSW, the closely related African Olive (*Olea europaea* subsp. *cuspidata*) is now asserting itself as an invasive species. It is a dense-crowned small to medium tree (up to 15 metres) that is part of the tropical wild olive group, and well adapted to temperate and sub-tropical regions. Its major area of natural distribution is eastern Africa, with smaller occurrences in the Middle East, northern India, Afghanistan, Pakistan, Kashmir and China. It occurs naturally in a wide range of habitats from rocky hillsides to river banks, and grows in rainfall zones from about 100 mm near the Red Sea to about 1200 mm in the Ugandan highlands.

Introduction into Australia

African Olive was introduced into cultivation in NSW as a hedging plant and rootstock during the mid-1800's, and is closely linked to agricultural pioneers John and William Macarthur and the development of the famous Camden Park Estate, near Camden. It was subsequently planted at properties throughout the Camden district, which is now a major centre of African Olive spread. It is still used occasionally as a rootstock for European Olive, however the small fruits have no commercial value and do not produce extractable oil.

Key Aspects of Biology and Environmental Impacts

African Olive plants are capable of producing fruits at age five years, with mature trees capable of bearing more than 25,000 fruits per annum. At an average size of 7 mm, the sweet black fruits are smaller than European Olive and readily consumed by a wide range of native and introduced bird species. Dense seedling 'mats' (Fig. 1), at densities of up to 950 seedlings/m^2 (Cuneo & Leishman 2006), form in the seed fall zone of mature plants. Seedlings are able to remain at this 'seedling bank' stage for many years. Through bird dispersal, African Olive seed is highly mobile in the landscape, and is able to invade eucalypt woodlands as seedlings establish in 'halos' around large perch trees (Fig. 2). It is not known whether ingestion by birds increases seed germination, however germination from whole olive fruits does not usually occur until about 15 months after dispersal. Once established in bushland areas, African Olive is able to spread progressively and out-compete native understorey species for light and moisture.

African Olive is a long-lived tree (100+ years) (Fig. 3) and thrives on the hilly terrain and clay soils of the Cumberland Plain region west of Sydney, eventually forming dense monoculture stands and a continuous mid-canopy which excludes the regeneration of native species. In the southern Cumberland Plain (Camden-Picton region) the landscape scale of African Olive infestation is now a significant threatening process, with over 1900 hectares of dense olive mapped there. The remaining vegetation of the Cumberland Plain is now restricted to 13% of the landscape, and exists in a highly fragmented state. Fragments are highly vulnerable to weed invasion, a process that threatens many of the twelve endangered ecological communities present on the Plain. Threatened plants from the Cumberland Plain region also at risk from African Olive invasion include *Pimelea spicata* and *Acacia pubescens* (Coutts-Smith & Downey 2006).

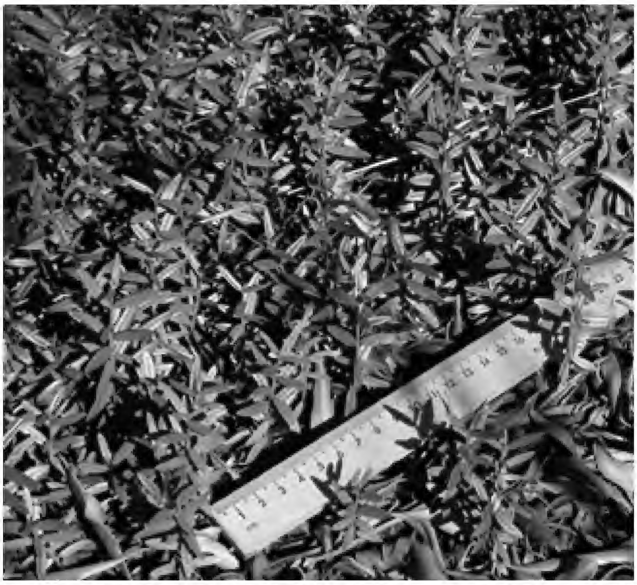


Figure 1. Dense seedling 'mats' form around mature African Olive plants. Photo: Peter Cuneo

Control Techniques

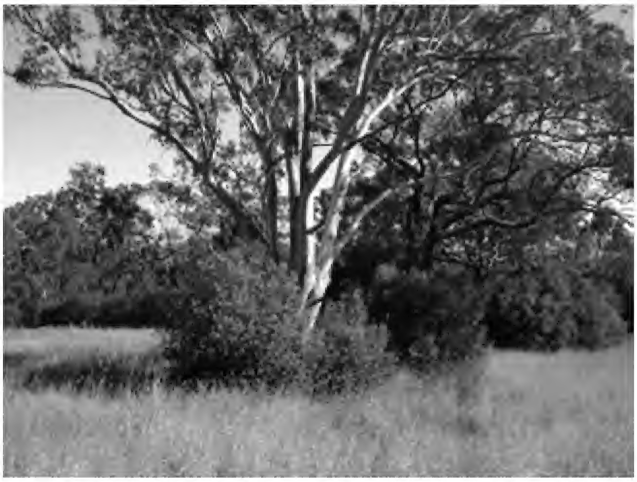
Bushland management practitioners consider African Olive to be a persistent and difficult weed to control. 'Cut and paint' treatment of established plants with undiluted Glyphosate (e.g. Roundup®) is a proven effective method, with herbicide applied immediately to the entire stump surface. Drilling and injection of mature plants with undiluted Glyphosate is also widely used to control established stands of African Olive. Young plants (less than 1 m high) are killed by low intensity fire (von-Richter *et al*. 2005), but mature plants resprout readily after burns. Seedlings can also be controlled by dilute Glyphosate or Metsulfuron-methyl (e.g. Brush Off®) spot spray. Metsulfuron-methyl is a selective herbicide and preferred for situations where native grasses are to be retained. Successful control of large mature (15+ years) stands of African Olive at Mount Annan Botanic Garden has been achieved with a program of drilling/herbicide injection, followed by mechanical mulching of dead plants. The native Olive Lace Bug (*Frogattia olivinia*) is a known pest of European Olive in Australia, and has potential as a biological control for African Olive, although this requires further research.

The Future of Invasive Olives in NSW

African Olive is highly invasive and can no longer be regarded as a 'sleeper' weed in NSW. Its establishment as an invasive species in regions outside Australia, such as the Hawaiian Islands of Maui and Kaua'I, is a clear indication of its adaptability and spread potential. It is highly adaptable and readily dispersed through the landscape, and already has impacted on native plant diversity in coastal areas of NSW. A regional African Olive control strategy is now urgently required for the Cumberland Plain and Hunter Valley regions.

Dispersal of seed by birds remains the key issue with invasive olives. With the increasing cultivation of European Olive into coastal NSW it must be assumed that there is potential for hybridisation with existing populations of African Olive. Hybridisation between European and African Olives will most likely result in trees that produce smaller fruits capable of being spread by birds into bushland areas. There is increasing awareness in the NSW olive industry regarding the weed potential of European Olives, and weed risk assessment modelling and mapping for both European Olive (similar to that done for South Australia) and African Olive in eastern Australia is recommended in view of the expansion of the olive industry.

Future spread and potential biodiversity loss from this 'next generation' of woody weeds will need to be considered with respect to the overarching threat of climate change. Potential for expansion is significant with both European and African Olives established in eastern Australia, and well adapted to both sub-tropical and Mediterranean climates. Modelling of native and invasive species response to climate change is complex and at an early stage of development, however it is clear that climate change will favour opportunistic invasive species, like these olives, that are readily dispersed in the landscape.



*Top: Figure 2. African Olive establishes as bird deposited seedling 'halos' around perch trees.
Bottom: Figure 3. The long lived African Olive can permanently change ecosystems. Photos: Peter Cuneo*

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Reconstructing complex grassland on agricultural sites by direct seeding: learnings from a 3 year, field-scale, experimental study

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Temperate lowland native grasslands are among Australia's most threatened plant communities (Kirkpatrick *et al.* 1995). The most common technique for restoring these grassland communities is by the reintroduction of plants germinated from seed and grown as container-stock under nursery conditions. This represents efficiencies in the use of limited seed resources. However, introducing individual plants is labour-intensive and expensive. In addition, the establishment and the development of self-perpetuating populations are seldom reported. Another approach to grassland restoration is by direct seeding. This technique has long been used in Australia for revegetation with native trees and shrubs, but has more recently been investigated for the reintroduction of herbaceous species (primarily grasses and a few selected forbs) (e.g. Windsor and Clements 2001; Gibson Roy *et al.* 2004; Cole *et al.* 2005). Some advantages of direct seeding over container grown (or transplanted) introductions, include the potential to work at large scales, lower labour and material costs, and the establishment of large numbers of plants.

To improve knowledge of the potential of direct seeding as a technique for grassland restoration, Greening Australia (Victoria) in partnership with the University of Melbourne undertook the Grassy Groundcover Research Project (GGRP), a three-year NHT funded study.

The focus of the GGRP was twofold:

- to investigate reintroduction of multi-species assemblages (representative of locally occurring remnants) onto land with an agricultural history; and
- to investigate the production of large quantities of high quality, provenance seed, in containerised production systems.

Field Methods

The GGRP was initiated in November 2004. Since then three annual sowings have been undertaken at each of 13 one hectare experimental sites across south-western Victoria (39 separate sowings in total). Sowing locations ranged from Bendigo in the state's central region, to Colac in the south, and from Hamilton in the west, to Minyip in the north. Each of the 13 sowing sites was located on agricultural land with a history of cropping or grazing.

The seed used in the sowings originated from either local grassland remnants (therefore taking into account provenance), or from plants propagated from the wild seed under controlled production facilities (Fig. 1). Most of the 200+ grassland species grown in these production facilities propagated readily from seed and were well suited to the intensive, above-ground seed production system used. Seed production (rather than wild collection) simplified seed harvest and produced reliable quantities of high quality, weed-free seed at times when field production was severely restricted from the effects of drought.

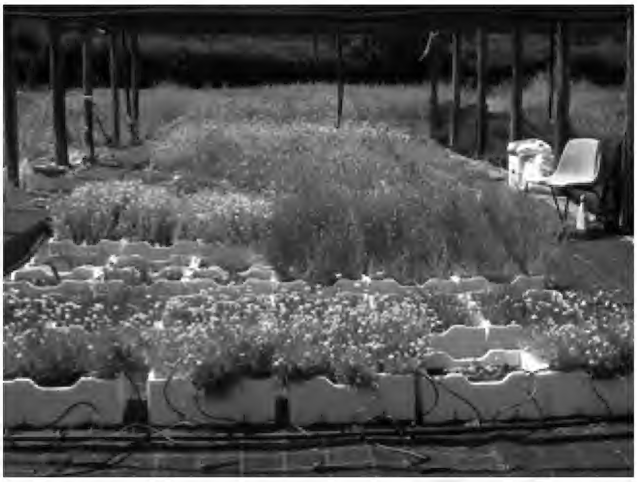

Figure 1. Plants grown in polystyrene containers under controlled nursery conditions in one of six seed production areas established to produce seed to supplement field collections. Photo: P. Gibson Roy

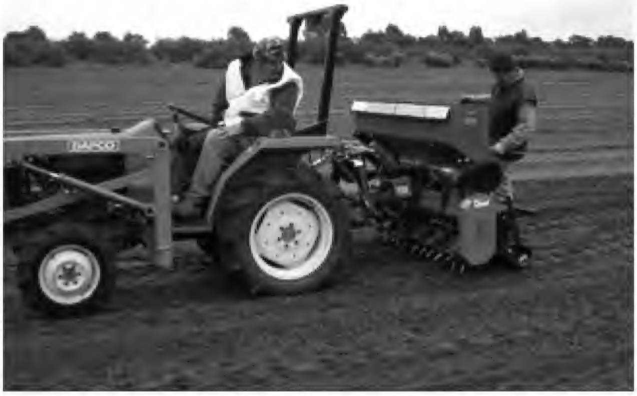

Figure 2. A modified turf seeder allows the sowing of multiple species in one pass. Photo: P. Gibson Roy

What Has Been Achieved?

At a time when climatic conditions (i.e. drought) were amongst the most challenging in living history, the GGRP sowings have established 13 ha of species rich grassland. Most encouragingly, our results suggest that it is possible to use mechanised equipment (Fig. 2) to sow complex combinations of grassland species under field conditions, and achieve high levels of establishment from a large number of grassland species (Fig. 3). Among these are many locally, regionally and also nationally threatened species. We have also noted high levels of subsequent recruitment of second generation individuals from many species established in each of the first two annual sowings.

Data from the first two years of experimentation suggest that soil removal or 'scalping' (Fig. 4) resulted in more effective weed control than either one or two years of traditional chemical control programs prior to seeding. Results comparing three years of chemical control (pre-seeding) with soil removal are yet to be analysed.

Invertebrate surveys have also been initiated to examine colonisation within these reconstructed grasslands. Preliminary results indicate quite rapid utilisation of the sites by a range of native invertebrate species. Investigations of plant roots from individuals established at these sites (across a number of species) indicate the presence of structures associated with functioning arbuscular mycorrhizae. Both findings suggest an increase in functionality at other trophic levels within these reinstated grasslands.

It is hoped that in future the findings from the GGRP will encourage restorationists and land managers to consider the use of direct seeding as a means to increase the range and diversity of herbaceous plant communities.

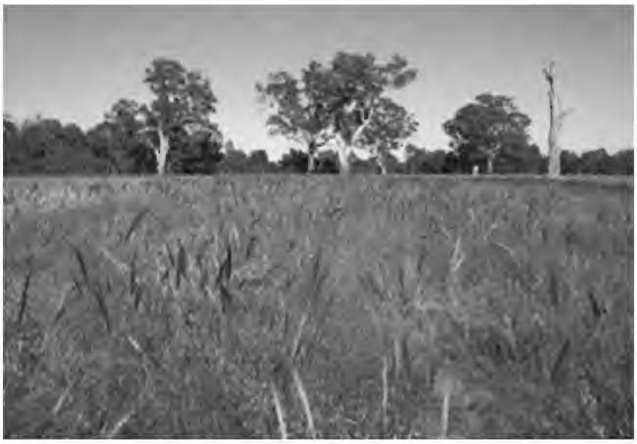

Figure 3. A scalped section within a sowing site (Laharum) 12 months after sowing, with a higher sward of Austrostipa mollis. *A large number of other grass and forb species is also present. Photo: P. Gibson Roy*

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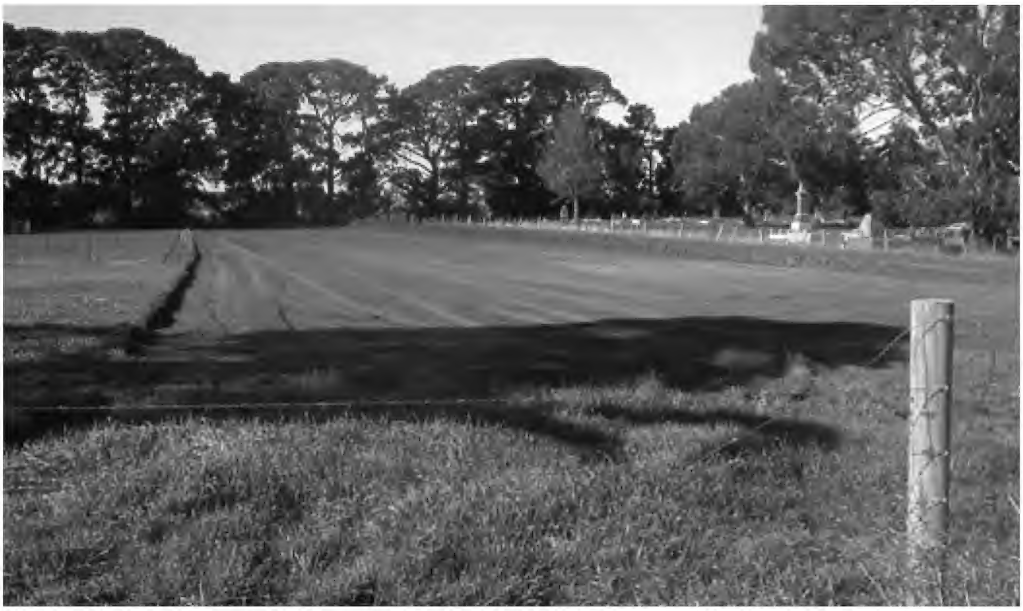

Figure 4. A 2000 m^2 scalping zone ready for seeding. This approach was found to reduce significantly subsequent weed competition from non-sown species. Photo: P. Gibson Roy

Challenges for native grassland conservation on Victoria's Northern Plains

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Temperate grasslands are among the most threatened and poorly-reserved ecosystems in the world (Henwood, 1998). This is reflected in southeast Australia which is estimated to have as little as 1% of its grasslands remaining. There has been an increased interest in research into management requirements and conservation of temperate grasslands in Australia in the past two decades. This paper outlines some of the challenges faced in attempting to retain and conserve grasslands on Victoria's Northern Plains over the past decade and highlights directions and opportunities for the future.

Northern Plains Grasslands and the Patho Plain

The vegetation communities of the Northern Plains have been extensively cleared and severely degraded since European settlement and the remaining 1% is fragmented into small remnant areas. The Northern Plains Grassland Community, which once dominated much of the region, is listed as a threatened community under the *Flora and Fauna Guarantee Act 1988* (Vic) and nominated for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). This grassland community is important as it is at the southern limit of the Riverina grasslands.

Grasslands of the Northern Plains are currently dominated by Wallaby Grasses (*Austrodanthonia* spp.), Spear Grasses (*Austrostipa* spp.) and Spider Grass (*Enteropogon acicularis*) with inter-tussock spaces filled with annual herbs. The Patho Plains region, between Mitiamo and Echuca, contains probably the largest remaining areas of grasslands in Victoria. These grasslands are important for a range of threatened flora and fauna species whose Victorian distribution is almost entirely restricted to this area – for example Red Swainson-pea (*Swainsona plagiotropis*), Slender Darling-pea (*Swainsona murrayana*), Plains-wanderer (*Pedionomus torquatus*) and Sun Moth (*Synemon*) species.

Conservation Achievements

The area of Northern Plains grasslands in public conservation reserves increased from about 100 ha in 1997 to about 2,900 ha in 2008, mostly through land acquisition. The purchase of the highly significant 1277 ha 'Davies property' for incorporation into a new Terrick Terrick National Park was a stimulus for a further seven individual land purchases funded by the Victorian Department of Sustainability and Environment's (DSE) Conservation Land Purchase Program and the Australian zGovernment's National Reserve System Program (NRSP) (Figs. 1 & 2). These sites are currently managed as individual nature conservation reserves. This has been complemented by protection on private land with the Trust for Nature purchasing land (Glassons Grasslands Reserve through the NRSP and another property which it will on-sell) and signing of two conservation covenants. A recent incentive scheme (BushTender) across the Northern Plains saw a number of landowners on the Patho Plains sign agreements for active conservation management on their properties, although no further permanent covenants have been achieved to date.

Top: Figure 1. Northern Plains Grassland and the Red Swainson-pea at the recently purchased Wanurp Nature Conservation Reserve. Photo: Deanna Marshall
Bottom: Figure 2. Northern Plains Grassland at Wanurp Nature Conservation Reserve. Photo: Hugh Robertson

Attempts to coordinate the increasing area of native grassland being managed for conservation across public and private land have resulted in the formation of a Northern Plains Conservation Management Network.

Most recently, the Victorian Environmental Assessment Council's draft proposals for public land in the region have seen recommendations for an expanded Terrick Terrick National Park incorporating all of the recently purchased grassland reserves and a series of smaller nature conservation reserves on public land currently used for other purposes (VEAC 2007).

Continued Clearing and Loss of Quality

Large scale losses in high quality grassland sites have occurred due to illegal cropping. Repeated cultivation destroys the values of the grassland and its associated species indefinitely (Fig. 3). Over the past decade, approximately 5052 ha of high-value grasslands have been lost on the Patho Plains due to change of land use, from dryland grazing to cultivation and cropping. In 2007 some 1,000 ha across two separate properties were cultivated and subsequently cropped for the first time, destroying one of the largest nationally-endangered Slender Darling-pea sites in the district. Recent surveys of properties which contained known or likely habitat for Plains-wanderers in the early 1990s have revealed that approximately 50% of these have been lost. In a number of instances, losses of high-quality grasslands have also occurred on public lands, and even conservation reserves, through illegal ploughing.

Despite native grasslands being considered a high priority for retention under Victoria's Native Vegetation Management Framework (incorporated into all local government planning schemes), regulatory frameworks have failed to halt the loss of this endangered ecosystem. A common failure by both landholders and local government agencies to recognise native grasslands as native vegetation of conservation value (see Williams and Cary 2001) has probably contributed to this ongoing loss. Also, to date none of the areas that have been cleared had planning permit applications, and until very recently there has been a general reluctance by government authorities to enforce legislation when unauthorised clearing has been discovered.

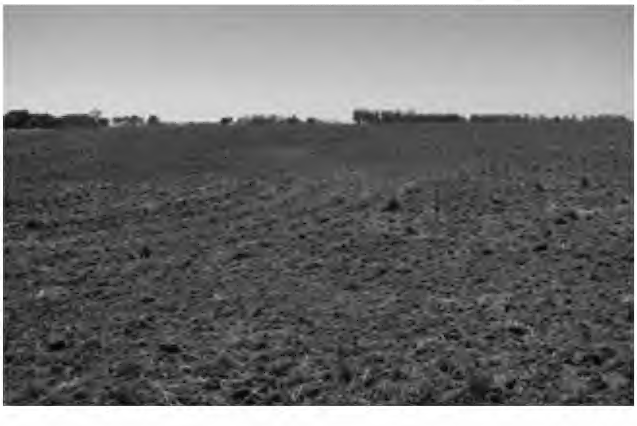

Figure 3. Recent illegal clearance of native grasslands on the Patho Plains. Photo: Terri Williams

Ongoing Challenges to Grassland Management on Public and Private Land

Besides a push towards agricultural intensification resulting in the large-scale losses outlined above, and local government zoning that encourages animal husbandry in the area, the ongoing management of remaining grasslands remains a challenge.

Compared with cropping, which requires soil cultivation that destroys the delicate soil crust, changing soil fertility and structure, grazing of native grasslands is a relatively more benign activity. Sheep grazing is currently used as a management tool for most grasslands in conservation reserves on the Patho Plains, in order to retain a mosaic of grassland structures, but with particular consideration of the habitat requirements of Plains-wanderers and other grassland fauna and flora that require open structure. The ecological impacts of this are the subject of ongoing research. On some private grasslands and some areas of public land outside the reserve system, unsustainably high stocking rates have and continue to result in the loss of diversity through prevention of seeding. This can exacerbate the impacts of drought, although drought is thought to potentially benefit native grass species over introduced annuals.

In a recent concerted attempt to raise awareness amongst landowners on the Patho Plains, letters were sent to all properties identified as containing native grasslands, informing them of the importance of the ecosystem and their legal responsibilities. The general response had a potentially better outcome for grassland conservation, in that it resulted in applications for planning permits for the removal of Northern Plains grasslands being submitted for the first time. This allows local government and DSE to undertake site visits and assess vegetation values to make informed decisions on vegetation clearance.

Protection of the remaining grasslands is invaluable for future strategic long-term conservation at a landscape scale in this area. A combination of tools such as land acquisition, incentives for private land conservation (either site protection or beneficial grazing regimes), a more vigorous application of planning scheme requirements, enforcement of state and national threatened species legislation, and the development of a strategic vision for the Patho Plains landscape would all contribute to this goal.

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Eucalypt dieback: an increasing threat in rural landscapes?

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The significance and potential scale of tree loss that could result from eucalypt dieback in rural areas is not widely appreciated. In the late 1970s-early 1980s severe dieback associated with high levels of defoliation by insects resulted in the loss of possibly half of the extant tree cover on some 300,000 hectares of the Northern Tablelands of NSW over a linear N-S distance of about 250 kilometres (Nadolny 2002). Both intensive agriculture (sown pastures and high inputs of fertiliser) and seasonal factors contributed to this. Given trends in land management and expected climatic changes, it is likely that such episodes of dieback will continue and may increase in frequency and intensity. Some mitigation measures are available to reduce the risk of dieback, but applying such measures on the scale necessary will be challenging.

What is Dieback?

Dieback describes a condition where trees die or decline in condition prematurely and often rapidly, with large numbers of trees usually being affected at once. Immediate causes of dieback vary and often several factors are implicated. Dieback in rural areas often involves repeated defoliation by various native insects, including leaf-eaters and sap suckers. Severely defoliated trees become susceptible to canker-causing fungi, which cause the branches to die. Several factors probably contribute to the insect outbreaks, including:

- favourable weather conditions for the damaging insects,
- clearing and pasture improvement benefiting scarab beetles,
- reduced effectiveness of control by natural enemies, and
- more nutritious foliage resulting from altered soil fertility or tree stress.

Other factors that may contribute to or directly cause dieback in specific instances include drought, salinity, *Phytophthora* root rot, other diseases, natural ageing of trees, self-thinning of dense regrowth stands and, at localised scales, hail, fire, mistletoes and herbicide spray drift (Nadolny 2002).

The Northern Tablelands Dieback

Woodland species, particularly New England Peppermint (*Eucalyptus nova-anglica*) and Blakely's Red Gum (*E. blakelyi*), were severely affected by eucalypt dieback in the late 1970s–early 1980s. Dieback even occurred in relatively dense woodlands with over 25% canopy cover, although properties with a high proportion of sown pastures were more affected (Fig. 1). Jones *et al*. (1990) estimated the resulting loss of trees, based on 192 sites on 19 properties in Southern New England in 1980. They found that over half of the standing timber was dead. Basal area of dead trees averaged 0.5 m^2 ha^{-1} compared with 0.4 m^2 ha^{-1} for living trees. Tree densities and numbers lost were both probably even higher on roadsides and travelling stock routes, with tree losses in the region probably totalling tens of millions.

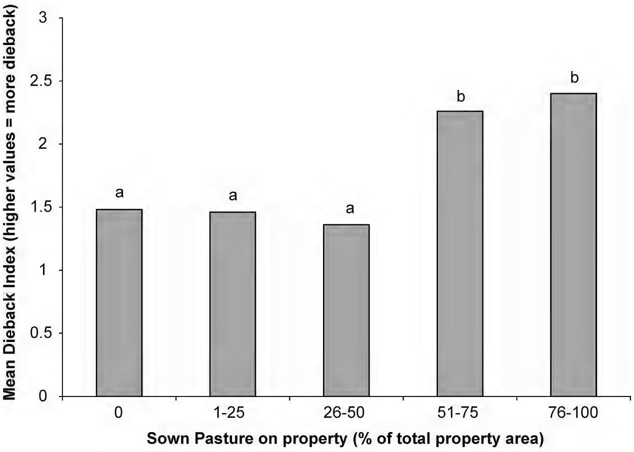

Figure 1. Effect of sown pastures on incidence of dieback in NSW and Qld properties (after Wylie et al. *1993). Mean Dieback Index of bars marked 'a' significantly differ from those marked 'b' (P < 0.05, Mann-Whitney U Test).*

Recent Trends

In recent years dieback has occurred in many parts of NSW, but has been less extensive on the Northern Tablelands. Recent occurrences in that region are mostly confined to areas where native vegetation is fragmented and pastures are heavily improved, although some stringybark regrowth forests and drought-affected sclerophyll communities have also been affected. On the plains, River Red Gum (*E. camaldulensis*) and Poplar Box (*E. populnea*) have been severely affected, especially in irrigated cropping areas, with likely contributing causes including drought, falling shallow water tables due to water extraction, insects and herbicide drift (Reid *et al.* 2007). Dieback has also occurred in districts on the Southern Tablelands, the South West Slopes, the Hunter and the North Coast, often where agricultural development is pronounced, and Bell Miner Associated Dieback is becoming a major issue in wetter forests. The recent drought has also affected trees.

During 2006-7 lack of water appeared to contribute to extensive mortality of river red gums on the Macquarie Marshes and of scattered paddock trees in large areas in the Central West.

Future Risks of Dieback

Despite efforts by many landholders, who have fenced-off remnants and re-vegetated, it appears that the risks of dieback are increasing once again due to intensification and expansion of agriculture and climate change.

Regional trends in agricultural development vary and are affected by seasonal factors. However, high commodity prices are currently driving investment in agriculture. An overall trend of intensification is illustrated by the increasing use of phosphate fertilisers since 1990 (Fig. 2). Fertilisers are of special concern because of suspected linkages between their use and tree health (Reid *et al*. 2007).

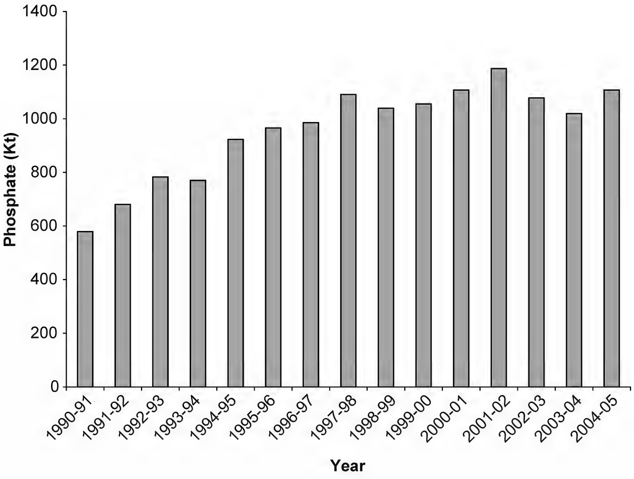

Figure 2. Use of phosphate (P_2O_5) in fertilisers in Australia (Source: ABARE Commodity Statistics 2007).

Climate change is likely to increase the incidence and severity of drought, hail, storm damage and bush fire, all of which can kill trees. In addition, a series of wet summers (such as 2007-8 on the Northern Tablelands) could result in outbreaks of insects. New causes of dieback, such as tidal intrusion of coastal streams are also expected. Accelerated climate change could result in massive losses of trees on a global scale, providing a positive feedback that would further increase atmospheric carbon dioxide. Even in the short-term, it is easy to envisage a future drought resulting in unprecedented losses of trees.

Already, insufficient trees are being established to replace current losses in many districts, let alone cover losses associated with another episode of dieback. We need to protect existing trees as well as ensure that lost trees are replaced. Reid and Landsberg (1999) estimated it would cost $19 billion to re-establish the trees on rural properties in temperate Australia. From this perspective, actions to protect existing trees are a sound investment.

Mitigation of Dieback

Various measures for mitigating the effects of dieback due to insects have been recommended and some of these already are well entrenched as principles underpinning conservation. These measures include protecting regenerating trees from livestock, providing sufficient habitat for predators and parasites of insect pests, linking areas of habitat, limiting agricultural intensification near trees, and fencing-off trees from livestock (Nadolny 2002). In the midlands of Tasmania, Neil Davidson (University of Tasmania) found that fencing-off remnants from livestock also significantly improves the health of trees suffering chronic drought effects. This response is not fully understood, but fencing-off could improve the trees' hydrological environment (e.g. improved infiltration of water) or indirectly reduce the impact of insects. The mitigation measures all have multiple benefits for biodiversity and are best inter-woven with regeneration strategies. Ideally, landholders should be encouraged to develop grazing systems based on low-input native pastures that facilitate natural regeneration of trees and provide other biodiversity benefits. Whatever approach is taken, a huge effort is required to ensure tree cover in rural areas does not decline further because of dieback.

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*New England Peppermint (*Eucalyptus nova-anglica*) woodland near Glen Innes in 1980. Photo: C. Nadolny*

A wetland rehabilitation prioritisation technique developed for the Sydney Metropolitan CMA

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Introduction

A technique was developed to prioritise wetlands for rehabilitation funding in the Sydney Metropolitan Catchment Management Authority (SMCMA) region. The existence of a published technique provides a transparent process for allocating funds. The prioritisation technique and wetland assessment method may have wider application.

Method

Eight Australian natural area assessment methods (Table 1; see also Schaeper *et al.* 2007) were reviewed to ensure that current standards in assessment and prioritisation of land for conservation purposes were considered. Of these eight, Blanch (2003) and Butcher *et al. (*2007) provided methods for prioritising wetlands which were found to be similar and relevant to the SMCMA needs, and were thus used as the basis for the SMCMA's prioritisation technique.

The SMCMA wetland condition assessment method drew from the eight methods reviewed. All criteria used in them were compiled and grouped for similarity of intent. Criteria not relevant to the Sydney context, such as planning policies that do not apply in Sydney and the effects of irrigation on wetlands, were removed from the grouped criteria. All criteria common to four or more methods were chosen as SMCMA assessment criteria. Two variables of interest to SMCMA, *Cultural Values* and *Community Group Commitment*, were added to its list of criteria.

Results

Two wetland condition assessment tables were developed from the assessment methods reviewed, one for wetland values (Table 2) and the other for wetland threats (Table 3). Condition assessment, based on the criteria for both wetland values and threats, was trialed on nine wetlands in the SMCMA region of varying condition and found to rank wetlands across three condition categories, viz. low, medium and high.

In order to prioritise wetlands for rehabilitation funding, the following factors were considered.

1. Wetland condition: wetlands in the best condition (high and medium) and with low threats, and that represented each of the wetland types in the Sydney region, i.e. saline, lowland freshwater and upland wetlands.
2. Landholder willingness: wetlands managers with wetlands which ranked as high or medium condition would be invited to submit wetland rehabilitation proposals.
3. SMCMA priorities: rehabilitation projects were selected from proposals based on CMA priorities.

Table 1. Natural area assessment methods reviewed

1	Hawkesbury Nepean Saltmarsh Assessment	Sainty & Jacobs (1997a)
2	Hawkesbury Nepean Wetland Assessment	Sainty & Jacobs (1997b)
3	Wetlands on the NSW North Coast	Blanch (2003)
4	Waterways Health Check	Waterwatch Australia (2005)
5	Saltmarsh in Urban Areas, Sydney Harbour	Kessler (2006)
6	River Murray Wetland Prioritisation, SA	Butcher *et al.* (2007)
7	Biodiversity Hotspots Program Biometric	WetlandCare Australia (2007a)
8	Wetland Assessment Technique (Version 3.4)	WetlandCare Australia (2007b)

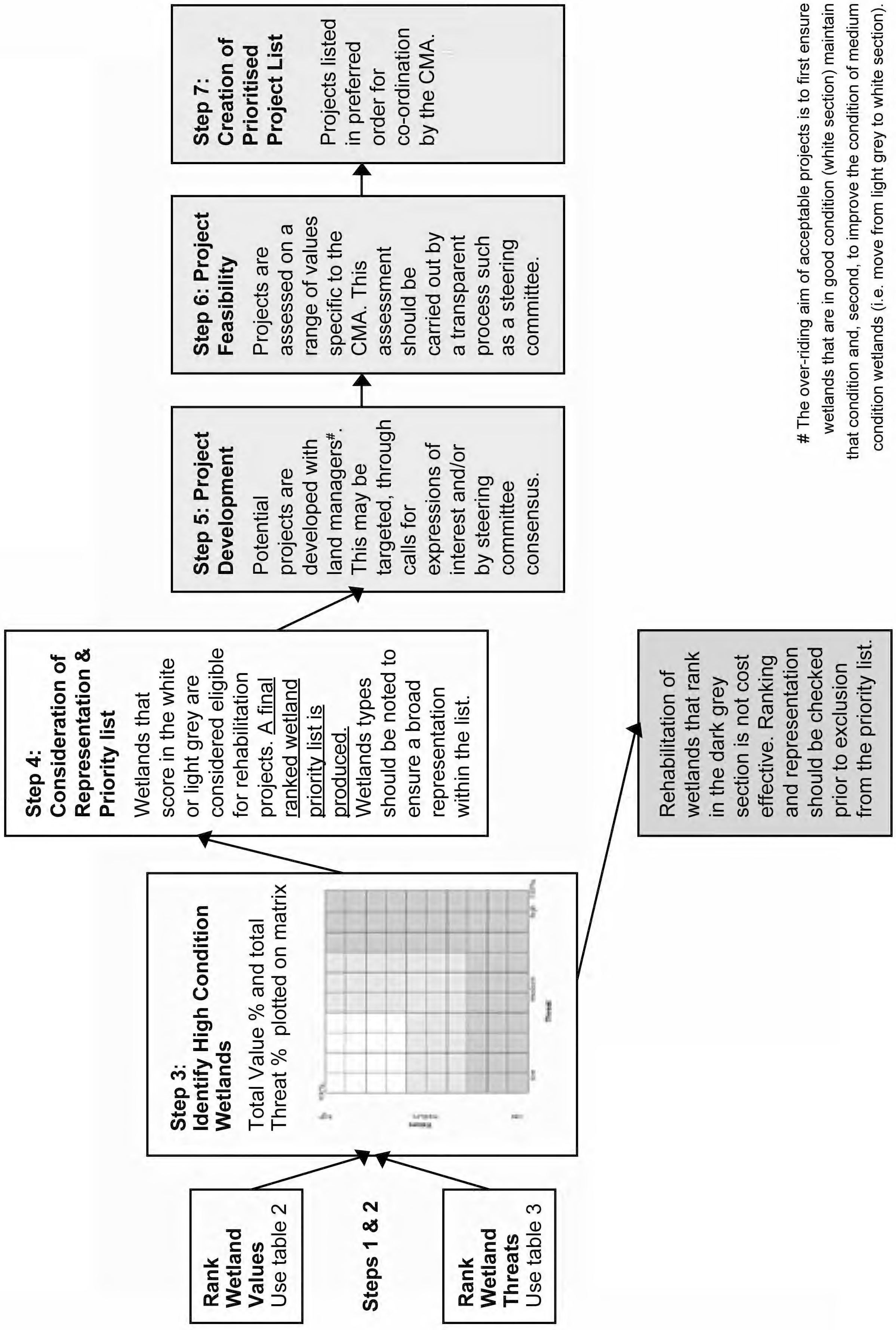
The process for selecting projects for rehabilitation is shown in Figure 1.

Discussion

The process for prioritising wetlands for rehabilitation funding was developed with the aims of ensuring wetlands currently in high condition remained in the high condition category, and improving the condition of medium condition wetlands. Implementation of actual rehabilitation works is largely dependent on landholder willingness and experience in handling work programs, government funds and associated paperwork.

The SMCMA wetland prioritisation technique was developed as a desktop model to reduce the portion of on-ground conservation funds spent on wetland assessment. Of the eight techniques reviewed, four used desktop information entirely or partially, and the two techniques designed for prioritisation of wetlands used desktop assessment only.

The SMCMA wetland rehabilitation prioritisation technique and wetland condition assessment method are suitable for use in the Sydney region. Although trialed just in that region, the value and threat criteria are broad enough to apply to a range of habitats and administrative systems. These criteria can be modified, within current intentions, to incorporate peculiarities of other regions.



Steps 1 & 2

Rank Wetland Values Use table 2

Rank Wetland Threats Use table 3

Step 3: Identify High Condition Wetlands

Total Value % and total Threat % plotted on matrix

Step 4: Consideration of Representation & Priority list

Wetlands that score in the white or light grey are considered eligible for rehabilitation projects. A final ranked wetland priority list is produced. Wetlands types should be noted to ensure a broad representation within the list.

Rehabilitation of wetlands that rank in the dark grey section is not cost effective. Ranking and representation should be checked prior to exclusion from the priority list.

Step 5: Project Development

Potential projects are developed with land managers#. This may be targeted, through calls for expressions of interest and/or by steering committee consensus.

Step 6: Project Feasibility

Projects are assessed on a range of values specific to the CMA. This assessment should be carried out by a transparent process such as a steering committee.

Step 7: Creation of Prioritised Project List

Projects listed in preferred order for co-ordination by the CMA.

The over-riding aim of acceptable projects is to first ensure wetlands that are in good condition (white section) maintain that condition and, second, to improve the condition of medium condition wetlands (i.e. move from light grey to white section).

Figure 1. Flow diagram showing the wetland rehabilitation prioritisation process.

Table 2. Criteria and scoring for wetland values

VALUES	SCORES 0	 1	 2
Threatened species present on site.	none	flora or fauna	flora and fauna
Identified as a threatend wetland; record of a JAMBA / CAMBA species at the site.	0	1	> 1
Number of communities present, e.g. open water, sedgeland / salt marsh, shrubland, forest.	1	2 or 3	> 3
Proportion of site with a vegetated buffer.	none	< 50%	> 50%
Vegetation connectivity.	no connectivity	part of a local corridor	part of a regional corridor
Habitat value for faunal groups (hollow bearing trees, fallen timber, rocky outcrops, dead trees, shallow water, deep water, instream macrophytes, snags).	none	1 or 2 habitat elements	>2 habitat elements
Water quality (nutrients, clarity, odour).	bad	variable	good
Tidal flushing or natural flow regime.	altered variability or no flushing	modified	natural
Hydrological connectivity/fish passage.	inflow and outflow blocked, no fish passage	inflow or outflow modification, fish passage at certain tides, or, fish passage possible to reinstate	unrestricted flow paths between wetland and water source, allowing fish passage
Level of conservation commitment.	non-conservation zoning	environmental zone/overlay	conservation reserve/agreement
Cultural values.	none recorded	Aboriginal or European	high significance, or, Aboriginal and European
Community group commitment.	no community group	community group	highly active community group or > 1 group

Table 3. Criteria and scoring for wetland threats

THREATS	SCORES 0	 1	 2
Current land use.	consistent with conservation	inconsistent–low impact	not consistent with conservation–high impact
Surrounding landuse.	conservation	mixed open space and low density urban	intensive landuse / high density urban / industrial
Catchment impacts (sub catchment).	primarily conservation	mixed open space / urban	highly urbanized / intensive landuse
History of disturbance (grazing, logging, mowing, industrial, inappropriate access, contaminated sediments, etc).	compatible with conservation	low impact / reversible / temporary e.g. recreation	high impact / irreversible / permanent, e.g. infilling
Modification to flow–inflow (content of pipes, drains, weirs, floodgates leading into waterway).	natural flow	modified	no inflow
Modification to flow–outflow (content of pipes, drains, weirs, floodgates etc leading out of waterway).	natural flow	modified	no outflow
Other structures (concrete banks, piers, levees).	none	1	> 1
Acid sulfate soils.	no existing acid sulfate soil problem	existing acid sulfate soil problem that is manageable–action proposed in Plan of Management	existing acid sulfate soil problem –no action proposed
Weed cover.	< 10%	10-50%	> 50%
Weed seriousness (species).	low impact species	noxious/invasive terrestrial weeds	noxious/invasive wetland/water weeds
Site upkeep (rubbish, erosion, feral animals, mosquitoes).	few issues, well kept, strategic management (signs etc)	many issues managed	unmanaged - poor condition
Prognosis (condition in 5-10 yrs).	very good or better	good or same	poor or worse

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Scales of adaptive diversity reflect complex ecological processes: seed sourcing options for *Austrodanthonia* seed

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Background

The adequate supply of large quantities of low cost seed is an issue of strategic importance if revegetation activities are to expand towards large-scale revegetation. Obtaining seed from wild populations offers an economic alternative to sourcing high cost commercially produced seed but local seed sources may be rare and variable seasonal conditions can result in irregular local seed supplies. In these cases sourcing seed from distant locations commonly becomes the only option and brings with it potential problems of genetic integrity. Local seed sources are assumed to have an ecological and adaptive advantage over non-local sources and there is a widely held perception that local provenance seed is a preferred option in Australia (Mortlock 2000) and elsewhere in the world (SER 2002). The use of 'local provenance' seed thus is currently recommended despite problems of scale and the definition of 'local'.

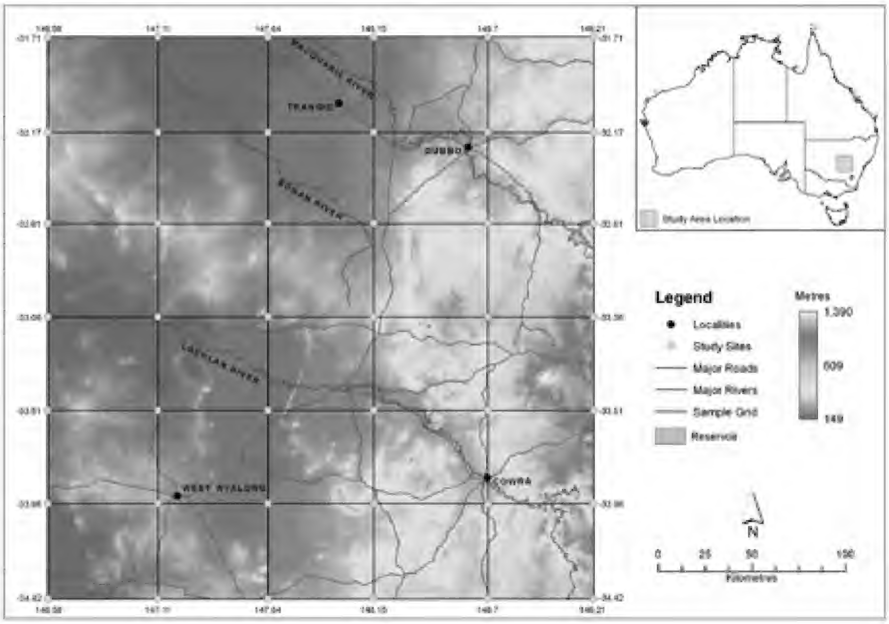

Figure 1. Collection area for Austrodanthonia *landscape genetics study. Cross-points represent a population.*

Austrodanthonia caespitosa (Wallaby Grass) is a widespread, cool season perennial found throughout southern Australia. The aim of this research was to understand the genetic structure of populations and their relationship with environment. This will not only have implications for revegetation success and the question of provenance but also for the management of native plant communities.

Research Outline

Over the past four years, this study examined the landscape genetics of *A. caespitosa* and four closely related species (*A. bipartita, A. eriantha, A. fulva* and *A. setacea*) in central western New South Wales. The study area (Fig. 1) is characterised by human disturbance. Differences in plant morphology, physiology, flowering and chromosome numbers of 28 populations were examined using common garden studies (i.e. taking plants from populations at different locations and growing them at the same loaction). These differences were related to environmental characteristics. Molecular markers were also used to examine the genetic structure between and among populations of *A. caespitosa.*

Research Outcomes – All Species

Most populations comprised at least four *Austrodanthonia* species. This means wildland seed harvesting most likely will contain a composite of species.

There is strong evidence for ecotypic variation for all species. Common garden studies found most of the variation in morphological and flowering characteristics occurred between populations and was related to the environment, suggesting local adaptation. No evidence of ecotypic variation in water-use efficiency was found for *A. caespitosa*, perhaps a trait not undergoing selection.

For all species except *A. eriantha* autumn was the dominant flowering period and spring the dominant period for growth. Flowering was also more protracted in spring compared to autumn when there was a high degree of flowering synchrony. More flowers were produced in autumn, a season that may provide less risky conditions for seedling

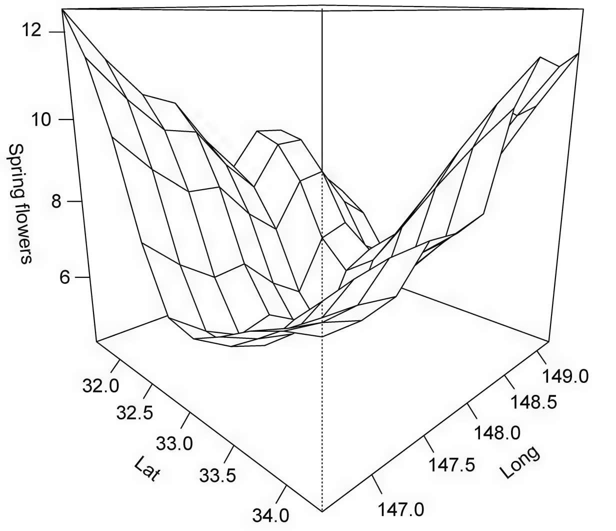

Figure 2. Relationship between number of flowers in spring and geographic location for 28 populations of Austrodanthonia caespitosa.

establishment. All species showed considerable overlap in flowering time, which may provide a possible mechanism to facilitate inter-specific hybridisation.

Compared to other species, *A. caespitosa* produced more flowers in both autumn and spring. High reproductive effort may be associated with the high recruitment rates commonly reported for this species and may prove to be a key to long term persistence of the species.

Widespread co-existent chromosome races occur for all species. Different polyploid races and putative intermediate races were found for all species and provide additional evidence for inter- or intra-specific hybridisation between chromosome races.

Research Outcomes – *Austrodanthonia caespitosa*

Northern populations of *A. caespitosa* produced more dry matter, more flowers and grew faster in spring than southern populations which had more growth in autumn. Northern populations also had higher variability in flowering times than southern populations.

It appears that *A. caespitosa* populations may adapt to flowering in two possible ways. Firstly, those populations growing in more summer-dominant rainfall areas (northern localities) have a more flexible flowering response (in relation to rainfall) and produce more spring flowers which may help to offset anticipated higher rates of seedling mortality due to higher evaporation rates. Secondly, highly synchronous flowering in autumn may ensure there is sufficient time for germination, seedling establishment and growth before the onset of winter.

The faster spring growth rates of *A. caespitosa* may be linked to a greater likelihood of summer rainfall in these areas, thus ensuring growth occurs rapidly before soil moisture disappears.

The reintroduction of southern populations into northern locations may result in less fit individuals and vice versa. Reproductive effort may not, however, be compromised with translocation as flowering may occur at any time for most species. However, a clear trend of reduced reproduction for populations of *A. caespitosa* within the centre of the collection area was found (Fig. 2). These populations were mostly located in or around the Lachlan River, where populations are largely confined to small remnants. This suggests the capacity for these remnant populations to persist may be compromised and sourcing seed from such sites may not be wise.

Regional trends in adaptation of *A. caespitosa* appear to be modified by small-scale site conditions. Across the collection area, *A. caespitosa* was associated with higher rainfall localities. However, within these localities individual plants tended to occupy the least-shaded, more exposed or drier sites.

Molecular studies suggest large amounts of gene flow between populations of *A. caespitosa*. More variation within than between populations was found which may reflect background gene flow.

Concluding Comments

This research clearly demonstrates that different traits can be expressed at different geographic scales making the definition of 'local' problematic. The formulation of broad recommendations for sourcing seed is therefore difficult. Decision-making tools that balance the benefits of different seed sources against ecological risks and economic costs may provide general guidance (Waters *et al.* 2007).

The current evolutionary architecture of *A. caespitosa* is complex and perhaps linked to the widespread polyploidy. This species coexists with a number of closely related species which may interact to provide both historic and contemporary broad-scale gene flow. This then appears to provide a breadth of genetic variation that is subsequently selected for by the wide range of environments occupied by this species. therefore in sourcing seed of *Austrodanthonia caespitosa* it may be more important to understand the nature and condition of seed source sites rather than the proximity to the revegetation activity.

Acknowledgements

My supervisors David Coates, Andrew Young, ron Hacker and Jim Virgona are kindly thanked for their vital contribution in this PhD study. The common garden studies were undertaken at Narromine Transplants, and funding was provided by the CrC for Plant-Based Management of Dryland Salinity and Charles Sturt University.

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ACT workshop report: identifying plants in the drizzle at Mulligan's Flat

Sally Stephens

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"It was wonderful!" – music to the ears of any course organiser! This "wonderful" course was the ANPC's *Identifying plants of grassy ecosystems of the ACT region*, held on 22 and 23 November 2007.

The course was field-based, with a short indoor introductory session each morning in the Australian National Botanic Gardens Theatrette. These sessions introduced beginners to plant structure, identification keys and plant identification for site assessment. Day one was designed for beginners and day two for those with more experience, though day one participants were welcome to register for day two.

Twelve botanists with an enormous skill-base tutored the course. These included two consultant botanists as well as the very obliging staff of several organisations (see Acknowledgements).

The course attracted wide interest and was fully subscribed well before the event. Eighty-eight people attended day one and 84 attended day two. As 55 attended both days, there were actually 117 individual participants, plus two assistants. Thirteen of the participants were sponsored community volunteers (see Acknowledgements).

Mulligan's Flat Nature Reserve was the field site, with day one and day two at different locations to avoid repetition. The participants broke into five groups and rotated around five sites, varying in landscape and vegetation type. Two tutors were based at each site with the rotation ensuring that all participants experienced the diverse skills of all the tutors. Two tutors roamed between sites, providing assistance and expertise where needed.

Rosemary Purdie showing that a dissecting microscope is sometimes essential. Photo: Sally Stephens

Learning plant identification for site assessment with Rainer Rehwinkel and Margaret Ning. Photo: Sally Stephens

Plant keys and other identification aids were at each site, and microscopes and computers with interactive keys were set up at one site. Each registrant received a 10x hand-lens as part of their registration and a copy of *Grassland flora – a field guide for the Southern Tablelands (NSW & ACT)*, donated by the Natural Temperate Grasslands Recovery Team.

Despite somewhat inclement weather, with heavy rain at the end of day one and light drizzle for the first half of day two, the participants were not deterred. Tarpaulins originally intended to shade the books, microscopes and computers were in fact needed to shelter them from drizzle!

Evaluation

Almost half (48.5%) of the evaluation forms were returned, with analysis revealing a high level of satisfaction (for example, 87% agreed that the course would have ongoing benefits). For full analysis, see the ANPC website.

Some 45% of respondents were involved in Landcare and other community groups or were private landholders or 'interested individuals'. As the conservation of grassy ecosystems often depends on volunteers and their dedication, they were a key focus group for this course. As well as training in plant identification, the course also provided them with resources and networks to continue to build their skills.

The form also provided space for individual comments and suggestions. One of the sponsored volunteers offered:

Thanks to you and all those who organised & presented the course. It was wonderful - diverse and useful information, well presented, tightly packaged - no wasted time. You deserve some applause.

Acknowledgements

The course was supported by an ACT Environment Grant. Course tutors generously provided their expertise and time: Greg Baines (ACT Parks, Conservation & Lands); Rainer Rehwinkel (NSW Department of Environment and Climate Change); Laurie Adams, Brendan Lepschi, David Mallinson and Andrew Slee (Centre for Plant Biodiversity Research); Anthony Whalen (Department of the Environment, Water, Heritage and the Arts); Bindi Vanzella (Greening Australia); Margaret Ning (Friends of Grasslands); Rosemary Purdie (ANPC), plus the funded consultant botanists Isobel Crawford and David Eddy.

Sponsorship covered the course fees of 13 community volunteers: ACT Parks, Conservation and Lands (4); the Commonwealth Department of Defence (4) and NSW Department of Environment and Climate Change (5).

The Natural Temperate Grasslands Recovery Team donated 120 copies of *Grassland flora – a field guide for the Southern Tablelands (NSW & ACT)*.

Volunteer assistance in the ANPC office was provided by Merryl Bradley.

Isobel Crawford guiding participants through the essential details. Photo: Sally Stephens

Artist **Beth Hatton** participated in the ANPC's November 2007 plant identification workshop at Mulligan's Flat. Together with **Christine James** she will present an exhibition called *Baseline: Remnant Grassland at Weereewa/Lake George*, from 17-24 July, 2008 in the Craft and Design Centre, Craft ACT, 80 London Circuit, Canberra. Hatton's sculptures, using native grasses (Kangaroo Grass, Silvertop Wallaby Grass) and exotic species (Serrated Tussock), and James' panoramic format paintings, explore the processes of colonisation which changed the Weereewa landscape and celebrate the resilience of indigenous grasslands and ecosystems which have survived.

Report from New Zealand Plant Conservation Network

Bec Stanley

Email: Rebecca.Stanley@arc.govt.nz

New Zealand's Favourite Plant

Epilobium microphyllum (Willowherb) won the annual New Zealand Plant Conservation Network web-based poll to find New Zealand's 'favourite plant'. The poll encourages website use and gives voters a chance to view plants they might not ordinarily see.

One million visits to the website

In the first week it was launched the Network website had 125 visits. It now receives over 10,000 per week and in December 2007 reached the impressive milestone of one million hits. The website was established to educate people about the native and naturalised components of New Zealand's flora and also to provide a focus for members of the NZPCN. It has certainly achieved that goal and is now a wonderful advertisement for the Government's Terrestrial and Freshwater Biodiversity Information System (TFBIS) which funded much of the initial development of the site. There are now 2,074 species illustrated on the site and the Network is now working to plug the remaining 296 image gaps. The goal is to have illustrated the entire native vascular flora by the end of 2008.

Epilobium microphyllum *(Willowherb).*
Photo: Naomi Lorimer

Links to on-line herbarium

The Network website now has links from its plant fact sheets to the on-line herbarium collection at Te Papa Tongarewa, the National Museum of NZ. It provides unparalleled access to images of herbarium specimens stored at the museum, including the Banks and Solander collection from Captain Cook's visits.

NZPCN Conference, 8-10 August 2008

Planning is well underway for our next NZPCN conference from Friday 8th to Sunday 10th of August at Te Papa in Wellington. Australian plant conservationists are more than welcome! The conference will have symposia on the science of plant conservation (8th) and plant conservation in practice (9th) and some exciting field trips (10th). For more information, email info@nzpcn.org.nz with 'conference' in the subject line to be placed on the mailing list,

Research Roundup

Benson, D. and Eldershaw, G. (2007). **Backdrop to encounter: the 1770 landscape of Botany Bay, the plants collected by Banks and Solander and rehabilitation of natural vegetation at Kurnell.** *Cunninghamia* 10(1): 113-138.

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Firn, J. (2007). **Developing strategies and methods for rehabilitating degraded pastures using native grasses.** *Ecological Management & Restoration* 8(3): 182-186.

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Vesk, P.A., Nolan, R., Thomson, J.R., Dorrough, J.W. and Nally, R.M. (2008). **Time lags in provision of habitat resources through revegetation.** *Biological Conservation* 141(1): 174-186.

Vivian, L.M., Cary, G.J., Bradstock, R.A. and Gill, A.M. (2008). **Influence of fire severity on the regeneration, recruitment and distribution of eucalypts in the Cotter River Catchment, Australian Capital Territory.** *Austral Ecology* 33(1): 55-67.

Conferences and Workshops

First National Local Government Environment Conference

9-11 July 2008
Shangri-La Hotel, Cairns, Qld

The conference will examine environmental issues related to climate change, planning reforms, sustainability and natural resource management and the opportunities and challenges they provide for Australian local governments in managing the environment into the future.

Further information: bron_browning@lgaq.asn.au

Australian Association for Environmental Education Conference Environmental Education up the Track: Hot Topics for our Community

9-12 July 2008
Charles Darwin University, Darwin, NT

The conference themes are *Communities make the system*, *Transcultural communication* and *Beyond rhetoric–improving our capacity*. Each theme will be explored on one day of the conference during concurrent sessions. Keynote speakers include Dr Mark Diesendorf, Institute of Environmental Studies, UNSW; Blair Nancarrow, Australian Research Centre for Water in Society, CSIRO; Dr Linda Ford, Rak Mak Mak Marranunggu elder; Jerry Schwab, Centre for Aboriginal Economic Policy Research, ANU; and Michael Christie, School of Education, CDU.

Further information: http://www.cdu.edu.au/ehs/AAEE/

New Zealand Plant Conservation Network Conference – Celebrating our Native Plant Life

8-10 August 2008
Te Papa Tongarewa, Wellington, New Zealand

This fifth NZPCN conference will include symposia on *Science and plant conservation* and *Plant conservation in practice*. Keynote addresses will cover *Genetics and conservation*, *Threatened ecosystems*, *Restoration of rare species* and *Plant conservation in practice*. A workshop will be held as part of the conference to plan a Plant Conservation Strategy for the next 5 years. Field trips will be conducted to Matiu/Somes Islands, the Eastbourne Hills, Karori Sanctuary and Otaris Wilton Bush.

Further information: http://www.nzpcn.org.nz

Volunteering Australia 12th National Conference on Volunteering – Catch the New Waves

3-5 September 2008
Radisson Resort, Gold Coast, Qld

The conference will explore current and emerging trends in volunteering using three subthemes: the shift in the way people are volunteering, flexibility in management, and the changing demographics of volunteering.

The keynote speakers are Bruno Ayres, Chief Networking Officer for the V2V Network (Volunteer-to-Volunteer), and Tim Costello, CEO of World Vision.

Further information:
http://www.volunteeringaustralia.org/html/s01_home/home.asp

Australian Systematic Botany Society Inc. Conference – Systematics and evolution in a changing environment

28 September – 3 October 2008
University of Adelaide, Adelaide, SA

Subject areas include evolution in a changing climate (e.g. aridity, salinisation); communicating and teaching systematics; speciation, co-evolution and adaptive strategies; systematics and evolution of weeds; non-vascular groups; and new approaches and technologies.

Further information:
http://www.anbg.gov.au/asbs/conferences/2008-adelaide/index.html

Wimmera Growers of Australian Plants Inc. FJC Rogers Seminar – Eremophilas 2008

4-5 October 2008
Horsham College Assembly Hall, Horsham, Vic

This seminar is for enthusiasts of Australian plants, and all gardeners who want to have an attractive garden with low water use. The keynote speaker is Dr Bob Chinnock, Senior Botanist, South Australian Herbarium, who recently published his revision of the genus *Eremophila* and allied genera. Other speakers are Norma Boschen, who has 30 years experience in growing eremophilas, and Dr Enzo Palombo, who will talk on anti-microbial properties of *Eremophila* extracts. A field excursion will include visits to three gardens predominantly planted with eremophilas and the Wail Arboretum.

Further information: http://home.vicnet.net.au/~wgapinc/

Advance notice of other conferences:

Interactions in science, interactions in nature. 33rd Annual Ecological Society of Australia Conference, 1-5 December 2008, University of Sydney, Sydney, NSW.

Ecology in a Changing Climate: Two Hemispheres – One Globe. 10th International Congress of Ecology, INTECOL, 16-21 August 2009, Brisbane, Qld.

Making Change in a Changing World. 19th World Conference on Ecological Restoration, Society for Ecological Restoration International (SERI), 23-27 August 2009, Perth, WA.

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L. Vallee, T. Hogbin, L. Monks, B. Makinson, M. Matthes, and M. Rossetto. 2004.
The Australian Network for Plant Conservation, Canberra Australia, 80 pages

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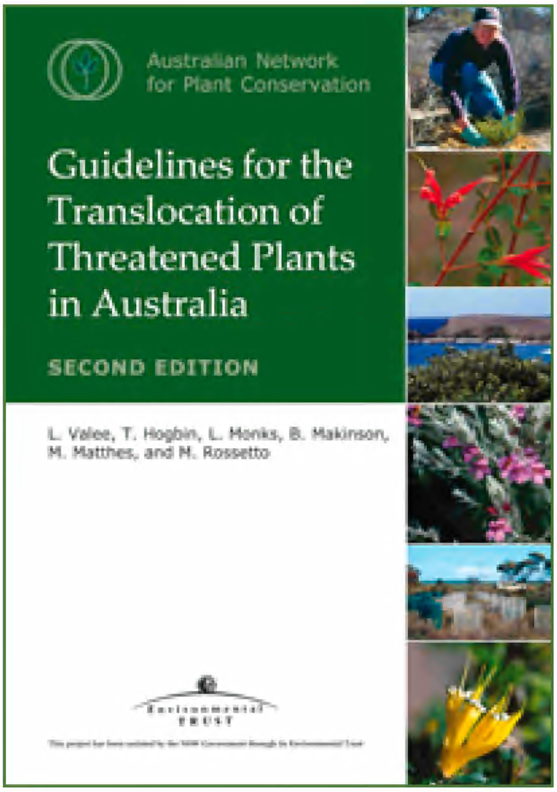

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L. Valee, T. Hogbin, L. Monks, B. Makinson, M. Matthes, and M. Rossetto

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